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OF

The Academy of Natural Sciences

OF

PHILADELPHIA

VOLUME LXIV

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THE ACADEMY OF NATURAL SCIENCES
LOGAN SQUARE
1912–1913

THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

FEBRUARY 8, 1913.

I hereby certify that printed copies of the PROCEEDINGS for 1912 were mailed as follows:—

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EDWARD J. NOLAN,

Recording Secretary.

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EDITOR: EDWARD J. NOLAN, M.D.

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* These papers are published in full in the Commemorative volume of the Academy's JOURNAL (XV).

PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1912.

JANUARY 2.

PHILIP P. CALVERT, PH.D., in the Chair.

Nineteen persons present.

The Council reported the appointment of the following Standing Committees to serve during the year:

FINANCE.—John Cadwalader, Edwin S. Dixon, Charles Morris, James D. Winsor, and the Treasurer.

LIBRARY.—Thomas H. Fenton, M.D., Thomas Biddle, M.D., George Vaux, Jr., Henry Tucker, M.D., Frank J. Keeley.

PUBLICATIONS.—Henry Skinner, M.D., Witmer Stone, A.M., Henry A. Pilsbry, Sc.D., William J. Fox, Edward J. Nolan, M.D.

INSTRUCTION and LECTURES.—Henry A. Pilsbry, Sc.D., Charles Morris, Witmer Stone, A.M., Henry Tucker, M.D., George S. Morris.

Mr. Frank J. Keeley was appointed Curator of the William S. Vaux Collections.

George Vaux, Jr., was appointed the Solicitor of the Academy.

DR. HENRY LEFFMANN made a communication on recent advances in photography as aids in teaching natural history. (No abstract.)

JANUARY 16.

HENRY TUCKER, M.D., in the Chair.

Forty-four persons present.

The deaths of the Rev. Charles A. Dickey, June 10, 1910, and of Edward Potts, January 4, 1912, members, were announced.

William L. Bailey made a beautifully illustrated communication on an ornithological trip to the Magdalen Islands. (No abstract.)

G. B. Haekel, Edwin B. Bartram, and Henry D. Pratt were elected members.

The following were elected Correspondents:

Viktor Goldschmidt, of Heidelberg; Charles Haskins Townsend, Sc.D., of New York; Carlotta J. Maury, Ph.D., of New York; John C. Branner, Ph.D., LL.D., of Leland Stanford Jr. University.

The following was ordered to be printed:

STRUCTURAL PECULIARITIES IN AN ABNORMAL QUEEN BEE.

BY J. A. NELSON, PH.D.

In May of the present year (1911) the Bureau of Entomology received through the kindness of The A. I. Root Company, Medina. Ohio, an abnormal queen bee, together with the cell from which she emerged. These had been originally sent to the company by the Rev. A. Francois, Parish Priest of Grand Bay, B. W. I. Father Francois also sent a letter containing the following data: The queen was hatched in 18 days after the colony became queenless, the cell being formed on drone comb. She was very active and Father Francois mistook her for a hermaphrodite, "half queen and half drone."

The queen when received was alive, and appeared to be in good condition. It was planned to introduce her into a colony to test her fertility, but she perished by an accident before this could be carried out. A careful examination of the exterior of the dead queen showed nothing abnormal or unusual in the structure of the head, thorax, or appendages. The abdomen, however, was of a very unusual shape. Instead of the long tapering conical form characteristic of the normal queen bee (fig. 1 D), it was in this case broadly ovate, as fig. 1 A and C show. Moreover, the three terminal segments were bent strongly ventrad, so that the outline of the abdomen suggests that of the drone, having a blunt apex, and doubtless was the cause of Father Francois' supposition that this bee was hermaphroditic. A more careful examination of the abdomen disclosed further abnormalities. In correlation with the unusual breadth of the abdomen, the sternites of the 5th and 6th segments are much broader than in the normal queen (fig. 1 C). They are, moreover, somewhat asymmetrical, as is also the sternite of the 4th segment, although to a slighter degree. Most modified of all is the sternite of the 7th segment. In the normal queen (fig. 1 D) this has approximately the outline of an isosceles triangle with a small notch at its caudal apex. In the abnormal queen (fig. 1 C) this plate is so much reduced by shortening in the longitudinal axis that it is almost completely covered and concealed by the sternite of the 6th segment.

This reduction of the 7th segment in part accounts for the strong downward flexure of the abdomen. In addition, the caudal notch is very wide and deep, with a semicircular outline, and extends over fully one-half of the posterior border of the segment. The sting is also slightly abnormal, having a kink about midway of its length.

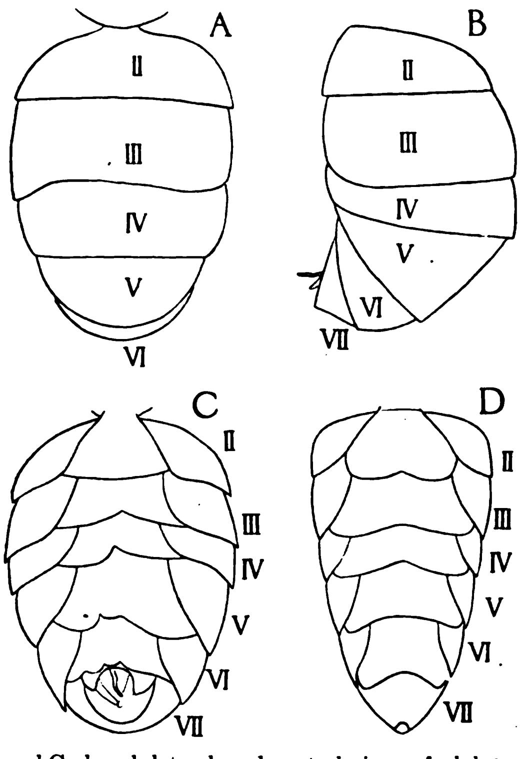

Fig. 1.—A, B, and C, dorsal, lateral, and ventral views of abdomen of abnormal queen. D, abdomen of normal queen, ventral view. × 5.

An examination of the internal organs showed other and more fundamental peculiarities. The poison glands, poison sac and spermatotheca (fig. 2 A) in their size and structure display no apparent abnormalities. The spermatotheca was empty, indicating that the queen was a virgin. The digestive tract also seemed to be normal. The sex organs, however, were strikingly modified. The left ovary (fig. 2 A and B), together with its duct, was entirely wanting. The right oviduct (fig. 2 B, OvD) was present, but compressed in a dorso-ventral direction, and bent in the sagittal plane into a sigmoid curve.

Attached to its upper end was a fusiform opaque whitish mass (Ov) 1.8 mm. in length, apparently representing a single egg tube, and seemingly containing only a single egg.

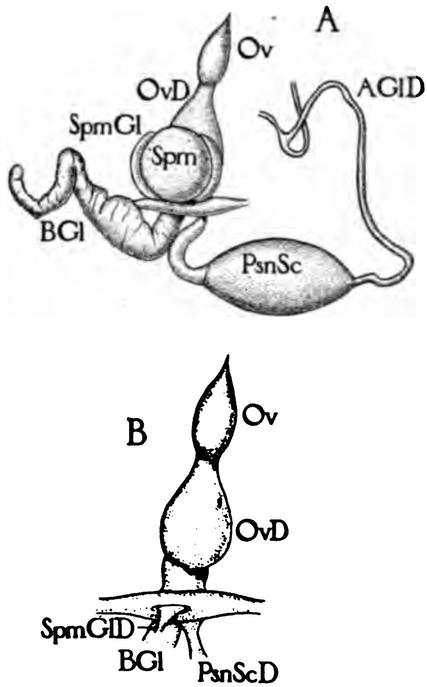

Fig. 2.—A, poison apparatus and sex organs of abnormal queen from dorsal side. × 7½. B, ovary and oviduct of abnormal queen. × 10. AGlD, duct of acid gland. BGl, alkaline gland. Ov, ovary. OvD, oviduct. PsnSc, poison sac. PsnScD, duct of same. Spm, spermatotheca. SpmGlD, duct of same.

As fig. 2 A and B show, the external openings of the poison apparatus on the one hand and the spermatotheca and vagina on the other are very close together. In the normal queen this is not the case since they are separated by a considerable interval, which is taken up by the dorsal wall of the bursa copulatrix. It is evident, therefore, in the case under consideration, that the bursa is very much shortened in an antero-posterior direction, in correlation with the shortening of the sternite of the 7th abdominal segment.

The cause of the abnormalities recorded here is entirely unknown. The cell from which this queen emerged was to all appearances entirely normal. Moreover, these abnormalities cannot be related to the sexual characters of the drone or the worker, except in so far as the reduction of the ovaries is peculiar to the worker, but in the latter case they are symmetrical. The queen is not in any way hermaphroditic, but merely abnormal in the reduction of certain parts of the abdominal wall and viscera.

FEBRUARY 6.

MR. STEWARDSON BROWN in the Chair.

Thirteen persons present.

The Publication Committee reported as follows:

An "Index to the scientific contents of the JOURNAL and PROCEEDINGS of the Academy" and a "History of the Academy" by the Recording Secretary had been accepted by the Centenary Sub-Committee on Printing and Publication to be issued in connection with the celebration of the One Hundredth Birthday of the society.

The following papers had been accepted as contributions to the Centenary Commemorative volume (the fifteenth of the quarto JOURNAL):

"Human Spermatogenesis: Spermatocytes and Spermatogenesis," by Thomas H. Montgomery, Ph.D. (Received November 28, 1911.)

"Early Adaptation in Feeding Habits of Starfishes," by John M. Clarke, A.M., LL.D., Ph.D. (Received December 16, 1911.)

"A Contribution to the Paleontology of Trinidad," by Carlotta J. Maury, Ph.D. (Received December 27, 1911.)

The following had been accepted for publication in the PROCEEDINGS:

"Structural Peculiarities in an Abnormal Queen Bee," by J. A. Nelson, Ph.D. (December 21, 1911.)

"Description of nine new Eels, with notes on other species," by Henry W. Fowler. (January 24, 1912.)

"Record of Fishes from the Middle Atlantic Coast and Virginia," by Henry W. Fowler. (January 24, 1912.)

The meeting was held in association with the Botanical Section.

Mr. Benjamin H. Smith made a communication on recent species of Cretægus. (No abstract.)

John H. Harshberger, Ph.D., spoke of the physiography and vegetation of the Florida Everglades. (No abstract.)

FEBRUARY 20.

WITMER STONE, A.M., in the Chair.

Twenty-nine persons present.

A resolution was adopted conveying a vote of thanks to Charles Marquedent Burns for an oil portrait of the Recording Secretary presented at the last meeting.

The Publication Committee reported in favor of publishing a paper entitled "Fixation of Single Type (Lectotype) Specimens of species of North American Orthoptera (Section One)," by James A. G. Rehn and Morgan Hebard (February 9) in the PROCEEDINGS.

The following had been accepted for publication in the Centenary Volume:

"Description of a new Fossil Porpoise of the genus Delphinodon from the Miocene Formation of Maryland." By Frederick W. True. (February 10.)

"Mimicry in Boreal American Rhopalocera." By Henry Skinner, M.D., Sc.D. (February 15.)

"The Petrographic Province of Neponset, Massachusetts," by Florence Bascom. (February 20.)

Prof. Ulric Dahlgren made a communication, beautifully illustrated, on the production of light by animals. (No abstract.)

The subject was discussed by Dr. Edward Anthony Spitzka.

Frederick Ehrenfeld and Francis B. Bracken were elected members.

The following were ordered to be printed:

DESCRIPTIONS OF NINE NEW EELS, WITH NOTES ON OTHER SPECIES.

BY HENRY W. FOWLER.

All the material treated in this paper is contained in the collection of The Academy of Natural Sciences of Philadelphia.

ALEBIDÆ.

Alebes rufus (Macleay).

Two from Victoria, Australia.

MONOPTERIDÆ.

Monopterus albus (Zuiew).

Five from Batu Sangkar and seven from Padang, Sumatra. Of the latter three are now in Stanford University.

SYNBRANCHIDÆ.

Synbranchus marmoratus Bloch.

Eleven examples from Peru, Pebas, Ambyiacu River, Surinam, Rio Grande do Sul, and Sao Joao to Rio Negro and Chapada in Brazil.

ANGUILLIDÆ.

Anguilla anguilla (Linnæus).

Sweden; Lake Lucerne, Switzerland; Munich, Germany; Italy (Bonaparte 398, 399, 400), Arno River. Twenty-four examples.

Anguilla japonica Schlegel.

Yodo River, Wakanoura, Matsushima and Kurume, Japan. Twenty-two examples.

Anguilla chrisypa Rafinesque.

Boston, Nantucket, Wood's Holl, Massachusetts; Noank, Connecticut; Long Island, New York; lower James River, Virginia; mouth of Kentucky River; Miami and Bayport, Florida; San Diego, Texas; Santo Domingo and St. Martins, West Indies. Besides many examples representing these localities, I have listed multitudes elsewhere from the Middle States region.

Anguilla mauritiana Bennett.

One from Padang, Sumatra; two from Samoa; two from Philippine Islands.

Anguilla bicolor McClelland.

One from Padang and two from Batu Sangkar, Sumatra. One of last now in Stanford University.

Anguilla australis Richardson.

One from Victoria, Australia.

SIMENCHELYIDÆ.

Simenchelys parasiticus Goode and Bean.

One from N. Lat. 42° 37′ W. Long. 66° 55′ in 200 fathoms.

SYNAPHOBRANCHIDÆ.

Synaphobranchus pinnatus (Gray).

One from N. Lat. 44° W. Long. 58° 30′ in 160 fathoms.

LEPTOCEPHALIDÆ.

Leptocephalus conger (Linnæus).

Atlantic City, Ocean City, Beesley's Point and Corson's Inlet, New Jersey; Italy. Seventeen examples.

Leptocephalus marginatus (Valenciennes).

Two from Christmas Island (W. H. Jones) and two from Hawaii (J. K. Townsend?), in Pacific Ocean.

Leptocephalus myriaster (Brevoort).

One from Hiroshima and eight from Tokyo, Japan.

Leptocephalus nystromi Jordan and Snyder.

Two from Nagasaki, Japan.

MICROCONGER subgen. nov.

Type *Leptocephalus caudalis* sp. nov.

Differs from the subgenus *Leptocephalus* in the well-developed caudal fin.

(*Μῑκρὸς*, small; *Κογγρος* or *Γογγρος*, the ancient name of *Leptocephalus*.)

Leptocephalus caudalis sp. nov. Fig. 1.

Head $7\frac{1}{2}$; depth $21\frac{1}{3}$; head width $3\frac{1}{4}$ its length; snout 4; eye $6\frac{1}{2}$; maxillary $2\frac{2}{5}$; mouth cleft $2\frac{3}{4}$; interorbital 9; pectoral $3\frac{1}{2}$; head $1\frac{1}{8}$ to dorsal origin; head $2\frac{1}{2}$ to anal origin.

Body long, rather well compressed, especially behind, and tail tapering long and slender.

Head long, greatest width about equals its greatest depth, profiles nearly alike. Snout long, not especially cavernous, surface convex, upper profile nearly straight, basal width about equals its length, and tip slightly protruding beyond mandible end. Eye ellipsoid,

rather large, close to upper profile, without eyelid, centre a little before first third in head. Mouth rather large, wide, rictus extending back behind pupil centre, though not quite opposite hind eye edge. Maxillary extends back trifle behind hind eye edge. Lips rather fleshy, broad laterally. Jaws strong. Teeth largely uniserial, uniform in size, conic, sharp-pointed, close-set and slightly inclined back along edges of jaws. In upper jaw front patch of slightly larger premaxillary teeth, these conic, sharp-pointed, and form continuous area back on front of vomer. Vomerine teeth similar to premaxillary teeth, in somewhat triangular area with apex directed back or towards pharynx, and teeth rather sparse behind. No other teeth on mouth roof. Teeth in mandible not continuous across symphysis, and an outer and inner series of small similar teeth on anterior portion of each ramus. Tongue smooth, elongate, rather narrowly triangular, and free in front. Mandible strong, shallow,

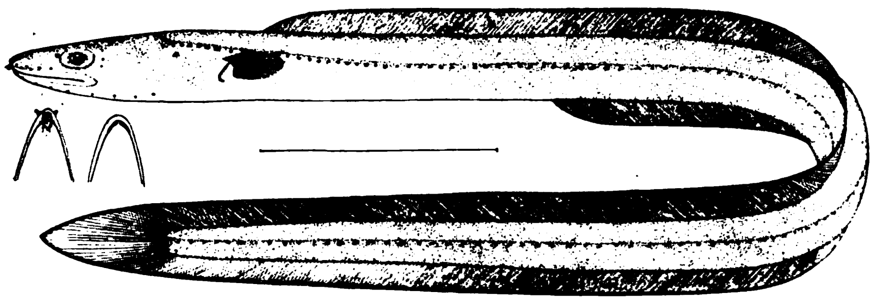

Fig. 1.—*Leptocephalus caudalis* Fowler. Type.

with low rami. Front nostril in short fleshy tube near snout tip. Hind nostril simple pore close before front rim of eye. Interorbital narrowly constricted bony ridge, surface convex.

Gill-opening begins opposite supero-median pectoral ray bases, curves slightly forward in crescent, about $1\frac{1}{4}$ in eye. Pharynx but little swollen.

Skin smooth. A pair of pores on upper lip at snout tip between nasal tubes, and immediately behind though more widely separated at point about first fourth in snout length another pair. Still closer than either of these pairs a third pair of inconspicuous pores on snout superiorly placed about first third in its length. A series of 6 pores from close after nasal tube till below lower front eye edge. Row of 9 pores on lower side of head beginning close behind mandibular symphysis, and last one just below opercle front on branchi-

ostegal region. Vertical series of 3 small pores behind eye short space on side of head. L. l. complete, a little high at first, then midway along tail side, and extending short space on tail. From above pectoral origin about 112 pores in l. l., of which 30 before vent. L. l. with about 7 pores before pectoral base, where continued on head side till its origin above opercle front.

Dorsal, anal, and caudal continuous, first with origin about midway in depressed pectoral length. Dorsal and anal moderately high, radii fine. Caudal large, length $1\frac{4}{5}$ in head, with numerous fine radii, contour elongate and sharply pointed behind, median rays longest. Pectoral small, elongate, inserted about midway in depth, radii fine, and fin rather pointed behind. Vent close before anal.

Color in alcohol largely dull or uniform russet-brown, lower surface of head and abdomen slightly paler. Snout tip deep brown. Iris slaty. Fins all plain pale brown. Edges of vertical fins narrowly dusky, becoming nearly blackish posteriorly. Lips and gill-opening pale.

Length $6\frac{3}{8}$ inches.

Type No. 1,055, A. N. S. P. Off Lower California. Dr. W. H. Jones.

Only the type known, and apparently distinguished from all other species of the genus by its large caudal fin.

(*Cauda*, tail; with reference to the large caudal fin).

Congrellus balearicus (De la Roche).

Four from Italy.

Congrellus anago (Schlegel).

> *Congrellus meeki* Jordan and Snyder, Proc. U. S. Nat. Mus., XXIII, 1901, p. 347, Pl. 11. Bay of Tokyo, Japan.

Three from Tokyo, Japan. One of these is typical of *Congrellus meeki*. Two others from Wakanoura, Japan.

Congrellus bowersi (Jenkins).

One from Honolulu, Hawaiian Islands.

Bathycongrus mystax (De la Roche).

One from the Mediterranean.

Atopichthys nuttalli sp. nov. Fig. 2.

Head $12\frac{1}{2}$; depth $12\frac{1}{4}$; head width $2\frac{1}{2}$ in its length; head depth at occiput 2; snout $5\frac{1}{4}$; eye $3\frac{1}{4}$; maxillary $2\frac{1}{2}$; interorbital $3\frac{3}{4}$; muscular segments about 17 + 143?.

Body oblong, greatly compressed, sides flattened, and only taper-

ing at head and end of tail so that long median area of similar great depth. Tail tapering rather suddenly, more acuminate than head.

Head widest part of body, little deeper than wide, profiles similar. Snout conic, width about $\frac{7}{8}$ its length and latter slightly projects beyond mandible. Eye large, impinging on upper profile, at first third in head, slightly ellipsoid. Mouth large, little oblique, nearly

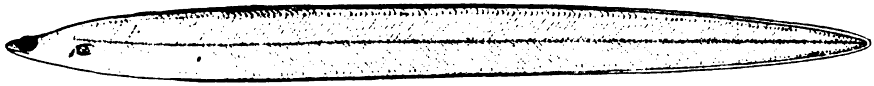

Fig. 2.—*Atopichthys nuttalli* Fowler. Type.

straight in commissure, and latter reaches about hind pupil edge. Teeth deciduous? (if present), as jaws at present entirely edentulous. Tongue far back, little developed. Mandible shallow, rami low, as seen from below rather attenuated. Nostrils small, well separated, similar, anterior near snout end and posterior close before eye. Interorbital moderately convex.

Gill-opening about $\frac{3}{4}$ in eye, inferior, nearly vertical or but slightly inclined forward, and begins above nearly opposite and close before pectoral origin.

Body naked, smooth, myomeres distinct.

Vertical fins low, continuous around caudal, latter very small, short and scarcely developed or less than $\frac{1}{6}$ in eye. Dorsal begins behind head a space about equal to eye and postocular region of head. Anal begins about first $\frac{2}{5}$ in total length. Pectoral well developed, rather high. Vent not distinct, apparently close before anal.

Color in alcohol uniform pale brownish, and no dark chromatophores evident now, if ever present in life.

Length $5\frac{11}{16}$ inches (146 mm.).

Type No. 1,042, A. N. S. P. Hawaiian Islands. Thomas Nuttall.

Only the type known. This is evidently a young apodal fish, possibly of *Leptocephalus* or some allied genus. I have not been able to locate it among any of the numerous forms described, as it differs in the combination of characters expressed in the above description.

(Named for Thomas Nuttall, from whom it was obtained many years ago.)

MURÆNESOCIDÆ.

Muræhesox savanna (Cuvier).

An example 40 inches long from Santo Domingo, West Indies.

Also a dried skin without data, though likely from the Mediterranean? (Bonaparte?). These examples show only such minor discrepancies as may be attributed to age, individual variation, or their preparation as specimens.

ECHELIDÆ.

Echelus myrus (Linnæus).

Two large examples from the Mediterranean. One contained the remains of a squill.

Myrophis vafer Jordan and Gilbert.

Two from Panama (McNiel).

Chilorhinus suensonii Lütken.

Three from Santa Cruz, West Indies.

Muræniohthys devisi Fowler.

Proc. Acad. Nat. Sci. Phila., 1907, p. 421, fig. 2. Victoria, Australia.

No. 33,120, A. N. S. P., type.

Muræniohthys ogilbyi Fowler.

L. c., p. 423, fig. 3, Victoria, Australia.

No. 33,121, A. N. S. P., type.

OPHICHTHYIDÆ.

Dalophis cœcus (Linnæus).

One from the Mediterranean.

Holopterura plumbea Cope.

Trans. Amer. Philos. Soc. Phila., (2) XIV, 1871, p. 482. West Africa.

No. 22,964, A. N. S. P., type.

Leiuranus semicinctus (Lay and Bennett).

Two from Hawaii.

Chlevastes elaps sp. nov. Fig. 3.

Head $17\frac{1}{5}$; depth at vent $65\frac{1}{2}$; D. about 557 + 25; A. about 263; head width $3\frac{3}{5}$ its length; head depth $2\frac{2}{3}$; snout $5\frac{2}{5}$; mouth $3\frac{2}{5}$; interorbital $7\frac{1}{5}$; eye $2\frac{1}{4}$ in snout; gill-opening $1\frac{1}{3}$; head $8\frac{1}{3}$ to vent; about 8 pores in l. l. before gill-opening, and 160 more to end of tail, of which 78 between gill-opening and vent.

Body extremely elongate, subcylindrical or but moderately compressed with convex sides, and long tail only appreciably tapering near end.

Head small, rather compressed, with swollen pharynx, and upper profile much more evenly convex than lower. Snout convex over surface and in profile tip firm, basal width $1\frac{1}{4}$ its length. Eye small

ellipsoid, without eyelid or skin of head extending over entirely, centre about first $\frac{2}{9}$ in head. Mouth small, commissure but slightly curved, rictus extends well behind eye. Lips rather broad, especially upper, fleshy, entire. Teeth all molar-like or rounded, upper lateral series distinct from vomerine or premaxillary, rather irregularly uniserial, begins about midway in snout length and continues back till opposite hind eye edge. Premaxillary and vomerine teeth continuous, former a little large and exposed below in front of closed mandible tip, and latter like lateral upper jaw teeth, though continued a little further posteriorly. Mandibular teeth irregularly biserial, anterior a little enlarged, not continuous across symphysis, and extend well back towards rictus. Tongue not evident. Man-

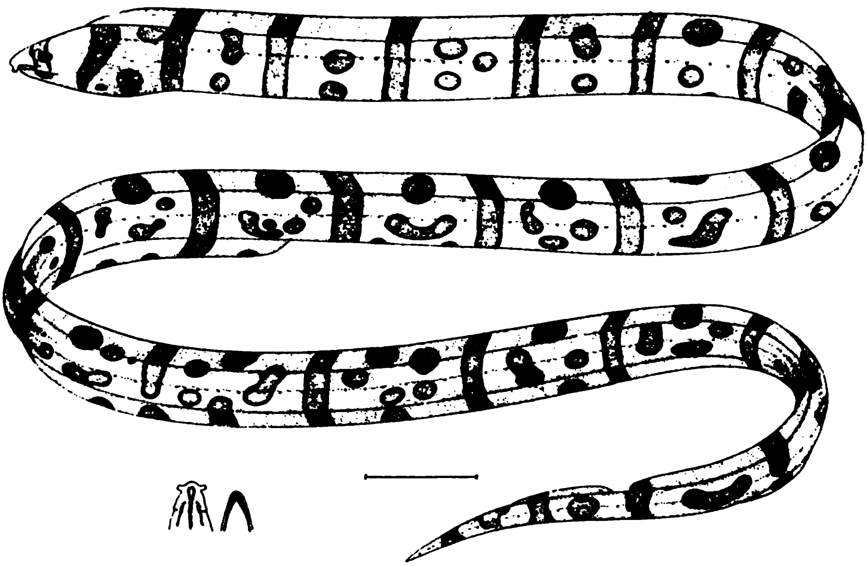

Fig. 3.—*Chlevastes elaps* Fowler. Type.

dible strong, shallow, symphysis obtuse. Anterior nostril in fleshy tube, before mandible tip, on upper lip. Posterior nostril large pore, with outer cutaneous edge opening downward below lower eye front. Interorbital evenly convex.

Gill-opening small, inferior, inclined back moderately.

Skin rather thin, smooth. Head with number of fine longitudinal wrinkles, though these mostly on pharynx. Some pores on mandible and lower side of head, these inconspicuous.

Dorsal origin nearer snout tip than gill-opening by space equal

to 1½ eye-diameters, fin begins high at origin, and remains so till well posterior, when but little lower. Dorsal ends about 1⅓ head-lengths from tail tip, after which a smaller low dorsal still posterior, this, however, only extending back about half way to tail tip. Anal little lower than dorsal, moderately developed, and posteriorly ends before end of dorsal. Tail end compressed, pointed, tip rather slender and flexible. Pectoral small, base broad, short, length about half basal width. Vent close before anal.

Color in alcohol largely pale or very dull brownish generally. Broad brownish transverse band over interorbital and down along each side of mandible, not continued below. Second head band about midway in head length, wider above than below. Third brown band of normal and regulation pattern, includes gill-opening, and continued below. This followed by 10 more on trunk and 12 on tail after vent, very few incomplete below. Alternating with bands 1 to 5 spots or blotches of dark brown in pale interspaces. Where close to vertical fins both spots and transverse bands continued on them. All dark blotches and bands with decidedly darker brown edges than their general color, line of demarcation between them slight, though greatly contrasting with pale color. Iris pale gray to slaty.

Length 27¾ inches.

Type No. 1,001, A. N. S. P. Philippine Islands.

This form approaches *Chlevastes oculatus* (Bleeker),[1] which has the narrow dark transverse bands 3, or more than 3, times narrower than the spotted or blotched interspaces.

Muræna colubrina Boddaert[2] shows 30 dark complete rings, the first including snout tip, second includes eye, and third would apparently include gill-opening, which is not satisfactorily indicated.

Muræna annulata Ahl[3] and *M. fasciata* Ahl[4] are two species the original accounts of which I have been unable to consult.

For *Ophisurus alternans* Quoy and Gaimard[5] figure an example with 31 dark and mostly complete rings, though only a few spots in a few of the interspaces. Their figure also indicates the dorsal origin over the gill-opening. *Ophichthys naja* De Vis[6] is said to

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[1] *Ophisurus fasciatus* var. *oculata* Bleeker, *Atlas Ich.*, IV, 1864, p. 64. East Indies.

[2] *Neu. Nord. Beytr.*, II, 1781, p. 56, Pl. 2, fig. 2. Amboyna.

[3] *Mur. Oph. Thunb.*, 1789, p, 8, Pl. 1, fig. 1. East Indies.

[4] *L. c.*, p. 9. East Indies.

[5] *Voy. Uranie*, Zool., 1824, p. 243, Pl. 45, fig. 2. Guam.

[6] *Proc. Linn. Soc. New South Wales*, 1883 (1884), p. 455. South Sea Islands.

have 27 dark rings, and some of the pale interspaces with a large oval spot. Its teeth are also said to be flat tubercular molars. (*Elaps*, a genus of serpents, some of which have a similar color-pattern.)

Cirrhimuræna chinensis Kaup.

Two from Padang, Sumatra. One of these is now in Stanford University.

Microdonophis erabo Jordan and Snyder.

Proc. U. S. Nat. Mus., XXIII, 1901, p. 870, fig. 17. Misaki, Japan.

No. 26,224, A. N. S. P., paratype.

Myrichthys oculatus (Kaup).

One from St. Martins, West Indies.

Myrichthys magnificus (Abbott).

Pisoödonophis magnifica Abbott, Proc. Acad. Nat. Sci. Phila., 1860, p. 476. Hawaiian Islands.

No. 1,013, A. N. S. P., type of *P. magnifica* Abbott. Also paratype No. 1,014, same data. The former is 27 inches long, though in the original description it is given as 19 inches.

Günther has recently[7] merged *Ophisurus ophis* (which he says is not *Muræna ophis* Bloch) Lacépède, *M. tigrina* Rüppell, *M. maculosa* Cuvier and *Ophichthys stypurus* R. Smith and Swain, in the synonymy of this species. However, Jordan and Davis long ago[8] pointed out that *Ophisurus ophis* Lacépède is evidently after "Bloch, as is shown by the enumeration of fin rays" and allow it, together with *Muræna ophis* Linnæus, as questionable synonyms of *Ophichthus havannensis* (Schneider).

Muræna maculosa Cuvier is based on Lacépède's *Ophisurus ophis*, which in turn is also based on *M. ophis* Bloch from Surinam?. Now *Ophisurus guttatus* Cuvier is based directly on *M. ophis* Bloch, so both of Cuvier's names are more likely synonyms of the American *O. havannensis* (Schneider).

Muræna tigrina Rüppell[9] is figured as showing the dorsal origin over the gill-opening, and the same is also stated in the text. The dark spots are indicated on the figure as quite large and regular, especially on the anal and belly. The eye is shown a little anterior in the mouth cleft. Rüppell also says "der nicht sonderlich gespaltene Mund und der Gaumen mit mehreren Reihen Hakenzähne

[7] *Journ. Mus. Godeffroy* (F. Südsee), XVII, 1910, p. 401.
[8] *Rep. U. S. F. Com.*, XVI, 1888 (1892), p. 629.
[9] *Atlas. Reis. N. Af.*, Zool., 1828, p. 118, Pl. 30, fig. 2. Mohila, Red Sea.

besetzt." It would seem from this that his fish is not even a *Myrichthys*.

Myrichthys stypurus (Smith and Swain)[10] may be identical with the present species, but several minor differences may at least be detected, such as its hind pectoral edge being lunate, dorsal and anal fins persisting almost to the tail tip where quite high, and the disposition of the spots.

For these reasons I decline to follow Günther.

Ophichthus rufus (Rafinesque).

Four from Italy.

Jordan and Davis state that the "description of *Echelus rufus* fits this species better [than *Echelus polyrinus* Rafinesque[12]], but the figure not at all." This is not true of my examples. Rafinesque's figure, though crude, is largely identifiable with the present species. The position of the dorsal and anal origins are correctly indicated, as well as the pectoral, though the snout is a little more pointed. In any case I feel obliged to adopt it, also because Bonaparte long ago used it in his MSS. *Ophisurus hispanus* Bellotti[13] will then be a synonym. I may further note that Jordan and Davis give[14] the vomerine teeth as biserial, though in my examples they are all uniserial. Moreau's rough figure of *O. hispanus*[15] agrees with my material.

Ophichthus triserialis (Kaup).

Herpetoichthys callisoma Abbott, Proc. Acad. Nat. Sci. Phila., 1860, p. 475. Pacific Ocean.

No. 38,148, A. N. S. P., type of *H. callisoma* Abbott.

Ophichthus stenopterus (Cope).

Ophichthys stenopterus Cope, Trans. Amer. Philos. Soc. Phila., (2) XIV, 1871, p. 482. Japan.

No. 1,043, A. N. S. P., type of *O. stenopterus* Cope. No. 1,044, same data, paratype.

Ophichthus uniserialis (Cope).

Ophichthys uniserialis Cope, Proc. Amer. Philos. Soc. Phila., XVII, 1877, p. 31. Pecasmayo Bay, Peru.

No. 21,152, A. N. S. P., type of *O. uniserialis* Cope.

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[10] *Ophichthys stypurus* R. Smith and Swain, *Proc. U. S. Nat. Mus.*, V, 1882, p. 120. Johnston I.

[11] Rafinesque, *Car. Nuov. An. Sicil.*, 1810, p. 65, Pl. 16, fig. 2. Palermo.

[12] Rafinesque, *Ind. It. Sicil.*, 1810, p. 69. Palermo.

[13] *Accad. Fisic. Med. Statist. Milano*, Sed. 23 dicembr. 1857.

[14] *Ophichthus hispanus* Jordan and Davis, *Rep. U. S. F. Com.*, XVI, 1888 (1892), pp. 624, 628. Palermo.

[15] *Hist. Nat. Poiss. France*, III, 1881, p. 584, fig. 212. Cannes, Nice.

Ophichthus ocellatus (Le Sueur).

One from Catolera, South America.

Ophisurus serpens Lacépède.

One from Italy.

MURÆNIDÆ.

Enchelycore nigrocastaneus (Cope).

Gymnothorax nigrocastaneus Cope, Trans. Amer. Philos. Soc. Phila., (2) XIV, 1871, p. 483. St. Martins, West Indies.

No. 16,032, A. N. S. P., type of *G. nigrocastaneus* Cope. Cope says "dorsal fin commencing above a point three lengths of the gape behind the end of the muzzle," which is not true of his type. The latter shows the gape 2⅔ to dorsal origin. The account, by Jordan and Davis, of *E. nigricans*[16] varies somewhat from my example, as they give the gape 2 in the head, mine showing clearly 2⅓. These writers also evidently had the type of *G. umbrosus* Poey for comparison, and while they state in their description that the tail is slightly longer than the rest of the body, Poey states that it is shorter. Poey's figure shows the jaws equal, the gape half way to the gill-opening, dorsal origin over gill-opening, and coloration marbled. Further, the specific name notes the animal as black, Günther giving the coloration as uniform black.[17] It would appear likely Cope's species has not been demonstrated as identical with *E. nigricans*.

Muræna helena Linnæus.

Three from Italy.

Muræna clepsydra Jordan and Evermann.

One from Panama (Ruschenberger). Also five others without locality, though likely from the same place?.

Muræna myrialeucostictus sp. nov. Fig. 4.

Head 7½; depth 16½; head width 4¼ its length; head depth 2⅛; snout 6⅛; eye 9½; mouth 2½; interorbital 11; head 3⅓ to vent.

Body long, rather deep, well compressed with surfaces of sides moderately or slightly convex, and rather deep tail tapering a little only at end rather suddenly.

Head compressed, a little swollen behind and at occipital region just behind eyes so that upper profile at that point rather deeply concave, sides rather flattened and scarcely constricted below. Snout with profile and surface rather evenly convex, somewhat conic in general form, basal width 1¼ its length. Eye a little ellip-

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[16] *Rep. U. S. F. Com.*, XVI, 1888 (1892), p. 588. Barbadoes, no loc., Cuba.
[17] *Cat. F. Brit. Mus.*, VIII, 1870, p. 135. Dominica, Grenada, Barbadoes.

soid, about midway in mouth length, without eyelid. Mouth rather large, nearly horizontal and not completely closing. Lips tough, rather thin, smooth. Teeth all conic and sharply pointed, mostly inclined a little back, and edges entire. Upper teeth in complete uniserial outer row, this extending entirely around jaw, all erect, anterior to eye more strongly convex and robust than behind eye, where more inclined back and somewhat compressed. Anterior to eye in upper outer series several teeth a little enlarged or slightly canine-like, one also at upper jaw tip. In front of upper jaw before eye, and inside erect outer teeth, about 3 series of 7 enlarged and more or less depressible conic canines. These arranged as 2 outer series approximating in front, with each containing 3 teeth, and a median posterior one, latter largest of all teeth in mouth and entirely depressible back. Beginning below eye front inside outer erect

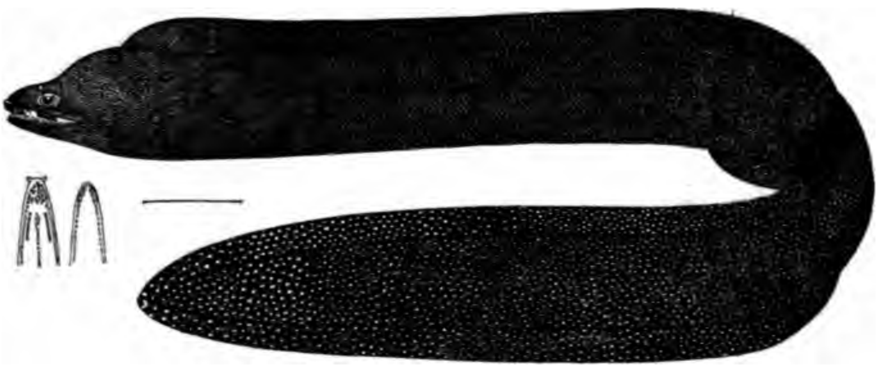

Fig. 4.—*Muræna myrialeucostictus* Fowler. Type.

teeth series of 6 rather slender and larger depressible palatine teeth each side of vomer. Latter with irregular biserial row of short conic strong teeth, smaller than upper lateral teeth. Mandibular teeth mostly uniserial, like upper outer erect teeth. Anteriorly in mandible about 3 pairs of sub-depressible conic and slightly enlarged teeth, first pair begins close behind or at symphysis. No tongue. Mandible shallow, curved, surface convex, tip equal in front with snout tip, rami low, and profile a little more inclined than that of snout. Front nostril in short tube above front eye edge in interorbital space. Latter evenly convex.

Gill-opening little below median axis of body, nearly horizontal, length a little more than eye. Pharynx well swollen, and with few obsolete shallow grooves.

Skin smooth, tough. Four pores on each upper lip, first close behind nasal tube, second midway in snout, third below front eye edge and fourth below hind eye edge. Pair of pores at snout tip, another pair between nasal tubes and third pair about midway in snout length above. Mandible pores inconspicuous, apparently 4? on each ramus. L. l. not evident.

Dorsal origin about midway between front eye edge and gill-opening, fin high and continuous with small caudal. Length of rounded caudal 1⅔ in eye. Anal similar, though lower than dorsal. Vent close before anal.

Color in alcohol deep chocolate-brown, head, body, and fins marked everywhere with minute pointed dots, very numerous, of much paler tint than general color and all rather distinctly defined. Towards end of tail and on caudal fin dots become whitish and a little larger. Inside mouth color very pale brownish. Angle of mouth brownish, though not darker than general coloration. Iris pale slaty, with narrow pale circle around pupil. Gill-opening edged with blackish. Edges of fin similar to general color, and also with similar dots.

Length 16½ inches.

Type No. 16,031, A. N. S. P. St. Martins, West Indies. Dr. R. E. Van Rijgersma.

Only the type, described above, is known. It differs from the related *Muræna melanotis*, as described by Jordan and Davis from South American examples, in the profusely dotted coloration, the absence of both pale and dark mandibular blotches near the rictus, and in having the mouth not completely closing. From *Muræna augusti* (Kaup) it differs in the partly biserial uniform vomerine teeth and the body being entirely dotted minutely with whitish.

(*Μυριὰς*, myriad; *λευκὸς*, white; *στικτὸς*, spotted.)

Rabula panamensis (Steindachner).

A single example without data, evidently from Panama?.

Evenchelys macrurus (Bleeker).

One from Padang, Sumatra.

I may here mention *Muræna thyrsoidea* Richardson is the type of *Thyrsoidea* Kaup by tautonomy, and thus Bleeker's restriction of *T. longissima* Kaup as the type is invalid. *Evenchelys* Jordan and Evermann has priority over *Rhabdura*, recently proposed by Ogilby.

Gymnothorax aquæ-dulcis (Cope).

Muræna aquæ-dulcis Cope, Rep. U. S. Geol. Surv. Hayden, 1871 (1872), p. 474. Rio Grande, near San Jose, Costa Rica.

No. 14,925, A. N. S. P., type of *Muræna aquæ-dulcis* Cope.[18] I may here state that the dorsal origin begins well before the gill-opening (Cope's statement to the contrary evidently erroneous in locating the exact origin of the fin), or near last two-fifths in space between latter and hind eye edge.

Gymnothorax eurostus (Abbott).

Thyrsoidea eurosta Abbott, Proc. Acad. Nat. Sci. Phila., 1860, p. 478. Hawaiian Islands.

No. 984, A. N. S. P., type of *T. eurosta* Abbott. This species appears distinct from *G. meleagris* (Shaw), with which Günther has united it. The vomerine teeth are partly biserial and short or bluntly convex, nearly molar-like.

Gymnothorax laysanus (Steindachner).

Lycodontis parvibranchialis Fowler, Proc. Acad. Nat. Sci. Phila., 1900, p. 494, Pl. 18, fig. 1. Hawaiian Islands.

No. 16,483, A. N. S. P., type of *L. parvibranchialis* Fowler.

Two without data (probably from Hawaii?) evidently this species.

Gymnothorax stellatus (Lacépède).

Three from Padang, Sumatra, of which one is now in Stanford University. One also from Apia, Samoa.

Gymnothorax undulatus (Lacépède).

Two from the Hawaiian Islands. One of these (from J. K. Townsend) I wrongly identified with *Muræna pseudothyrsoidea* Bleeker.

Gymnothorax kaupii (Abbott).

Thyrsoidea kaupii Abbott, Proc. Acad. Nat. Sci. Phila., 1860, p. 477. Hawaiian Islands.

No. 916, A. N. S. P., type of *T. kaupii* Abbott. I also confused an example from the Hawaiian Islands (W. H. Jones) with *M. pseudothyrsoidea* Bleeker.

This species seems to differ from *G. stellatus* in the presence of

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[18] I may note that Jordan and Davis identify an eel from San Diego, Cal., with Cope's species, and as they do not explicitly designate Cope's fish the former must be taken as the type of their genus *Rabula*. Therefore, the *Gymnothorax aquæ-dulcis* (nec *Muræna aquæ-dulcis* Cope) Jordan and Davis requires a new specific name.

Rabula davisi nom. nov.

Gymnothorax aquæ-dulcis (nec Cope) Jordan and Davis, Rep. U. S. F. Com., XVI, 1888 (1892), p. 598.

(Named for Mr. B. M. Davis, joint author with Dr. D. S. Jordan, in the review of the Apodal Fishes of America and Europe.)

three enlarged depressible canine teeth below the eye, as seen in the inner series in the upper jaw.

Gymnothorax flavimarginatus (Rüppell).

Three from Padang, Sumatra. Of these one now in Stanford University. They all agree with Rüppell's description to some extent. They differ from his figure in having only pale or dull-edged fins posteriorly. The figures by Bleeker have sharp-pointed teeth and may be different. Rüppell says, of *M. flavimarginata*, that it is very large, both jaws have a row of strong wedge-shaped teeth and the throat equally with similar teeth. The palatine teeth are said to be four long curved depressible teeth each side.

Gymnothorax batuensis (Bleeker).

One from Apia, Samoa. Apparently not identical with *Muræna flavimarginata* Rüppell, as thought by Jordan and Seale.

Gymnothorax kidako (Schlegel).

One from Tokyo, Japan.

Gymnothorax moringua (Cuvier).

Two from Bermuda Islands; one from New Providence, Bahamas; one from St. Kitt's, West Indies; one from St. Thomas, West Indies; three from St. Martins, West Indies.

Gymnothorax funebris Ranzani.

One from Santo Domingo, West Indies. Another without data.

Gymnothorax concolor (Abbott).

Thyrsoidea concolor Abbott, Proc. Acad. Nat. Sci. Phila., 1860, p. 479. Vera Cruz, Mexico.

No. 970, A. N. S. P., type of *T. concolor* Abbott. I have allowed this as a distinct form, Abbott's name having priority over *Muræna erebus* Poey,[19] which is said to have uniserial vomerine teeth. *M. infernalis* Poey[20] is said to have biserial vomerine teeth and also be identical with *G. funebris* Ranzani, though the latter does not describe the vomerine teeth. Jordan and Davis remark "there is no doubt of the identity of *funebris*, *concolor*, *castanea* and *infernalis*," though later Jordan and Evermann suggest *castanea* as probably distinct.

Gymnothorax unicolor (De la Roche).

One from Italy.

Gymnothorax carcinognathus sp. nov. Fig. 5.

Head $7\frac{2}{3}$; depth at vent $6\frac{4}{5}$; head width $3\frac{1}{2}$ in its length; head

[19] *Mem. Hist. Nat. Cuba*, II, June, 1861, p. 426. Cuba.
[20] *L. c.*, II, June, 1860, pp. 347, 354. Cuba.

depth 2; snout $4\frac{1}{3}$; eye $8\frac{1}{4}$; mouth $2\frac{1}{6}$; interorbital 11; head $3\frac{2}{5}$ to vent.

Body long, slender, well compressed, sides but slightly convex and tapering in long slender tail after vent.

Head well compressed, little swollen behind, sides a little approximated below, and profiles similarly inclined in front to form long conic slender muzzle. Snout conic, surface and profile convex, basal width half its length. Eye a little ellipsoid, about midway in mouth length, without eyelid. Mouth large, jaws curved like forceps and exposing most of dentition, thus not closing completely,

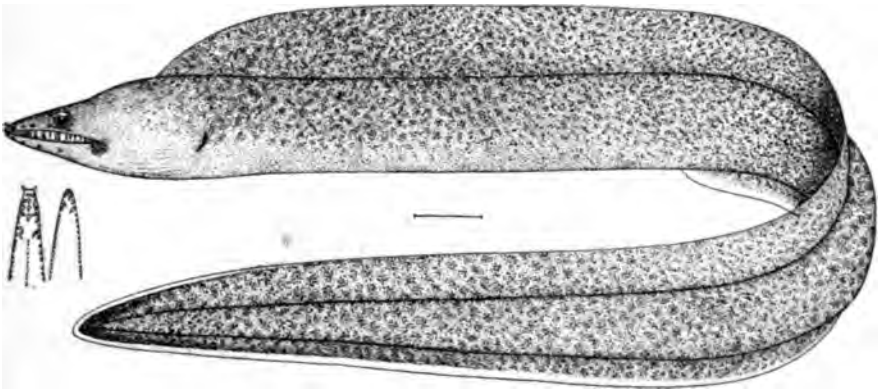

Fig. 5.—*Gymnothorax carcinognathus* Fowler. Type.

or with only their tips approximated. Lips rather thin, lower scarcely developed posteriorly on sides. Teeth conic, greatly acuminate, edges entire, and with slender sharp tips. An upper outer series of erect conic teeth, these with a distinctly smaller or shorter number most all their extent, all very slightly inclined back, though after eye more so. Before eye, in upper outer series of teeth 3 pairs of erect enlarged conic canines, alternating with 2 pairs of depressible conic canines, latter bend inwards. A depressible though shorter conic canine bends back towards vomer between first pair of anterior upper erect canines. This followed by 3 very long slender and slightly curved depressible canines, graduated from anterior to last in length, which longest of all teeth or but slightly less than horizontal eye-diameter. Below eye in outer upper series of erect teeth 2 canines, a little larger than most of teeth in their series, though not so large as anterior canines. Below front rim and close to 2 erect canines below eye, though directly inside, one or two

canines each side of palatine area, depressible towards vomer and conic. Vomerine teeth regularly uniserial, begins about opposite front pupil rim, first few a little larger than others which graduate much smaller behind, all conic and sharp pointed, also a little inclined posteriorly. Mandibular teeth uniserial, conic, rather compressed, inclined well posteriorly, mostly equal in size except in front, and all rather smaller than upper lateral teeth. On left symphyseal portion of mandibular ramus 2 enlarged erect and slightly curved conic canines, and on right symphyseal ramus same number. Between all these erect teeth a similar depressible canine, as one at symphysis, one between each erect pair, and a second on right ramus after second erect one. No tongue. Mandible slender, slightly curved, and a trifle shorter than snout tip, shallow, and surface convex. Front nostrils each in rather slender cutaneous tube each side of snout tip, and each about half of horizontal eye-diameter. Hind nostril simple pore above eye front in interorbital space. Latter depressed medianly, slightly convex.

Gill-opening a little below median axis, nearly horizontal and about equals eye. Pharynx rather swollen and forms greatest body depth.

Skin smooth, tough. Under surface and lower side of pharynx with several deep longitudinal grooves, about a dozen in number. Upper lip with 4 pores each side, first below nasal tube, third and fourth below eye, and second about midway in snout length. A pair of wide-set small pores at snout tip, another pair between nasal tubes and third pair a trifle nearer snout tip than eye. Each mandibular ramus with at least 4 inconspicuous pores. L. l. not evident.

Dorsal origin about midway between mouth corner and gill-opening, fin rather high, continuous behind with rather short and acuminate caudal. Latter about 1⅛ in eye. Anal like dorsal, only lower. Vent close before anal.

Color in alcohol rather light brown, with numerous indistinct mottlings and marblings of paler, especially on back and fins. Edge of dorsal with very narrow and at first marginal, though posteriorly or on tail submarginal, dusky line. On tail behind this replaced by still narrower and entirely marginal creamy edge. Latter continues around tail and whole length of anal, also becomes much wider and distinct on front of anal. Latter apparently without any distinct sub-marginal dark streak. A deep brownish blotch at rictus or corner of mouth. Gill-opening pale. Head rather uniform brownish above, and below paler and immaculate like abdomen.

Length 21⅜ inches.

Type No. 38,163, A. N. S. P. St. Martins, West Indies. Dr. R. E. Van Rijgersma.

Only the single example described above. It differs from the other West Indian species in its dentition, slender forceps-like jaws and coloration.

(Κάρκινος, forceps; γνάθος, jaw.)

Gymnothorax pictus (Ahl).

One from the Hawaiian Islands. This shows the posterior nostrils with a small or low cutaneous fringe, which in combination with the molar-like teeth likely allow it to enter *Sidera* Kaup as a valid subgenus.

AHYNNODONTOPHIS subgen. nov.

Type *Gymnothorax stigmanotus* sp. nov.

No vomerine teeth. Other teeth entirely uniserial, except three on premaxillary region of upper jaw.

This group differs from all the other subgenera included under *Gymnothorax* chiefly in the absence of, or in having deciduous, vomerine teeth.

(*A*, without; ὕννις, vomer; ὀδούς, tooth; ὄφις, snake; with reference to the absence of vomerine teeth.)

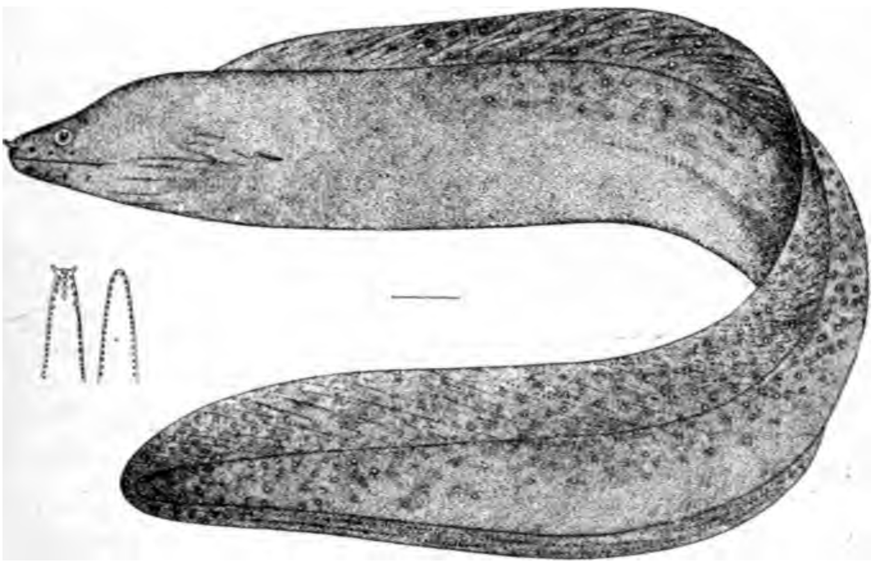

Fig. 6.—*Gymnothorax stigmanotus* Fowler. Type.

Gymnothorax stigmanotus sp. nov. Fig. 6.

Head $6\frac{3}{4}$; depth at vent $13\frac{1}{3}$; head width $3\frac{1}{2}$ in its length; head depth $1\frac{2}{3}$; snout $5\frac{3}{5}$; eye $12\frac{1}{2}$; mouth $2\frac{1}{3}$; interorbital 9; head $3\frac{2}{5}$ to vent.

Body long, well compressed, trunk rather deep, sides flattened, and tail tapering in rather long slender point from vent.

Head large, compressed, rather deep, with slightly swollen pharynx, flattened sides scarcely constricted below, attenuated in front, and upper profile indented above eye. Snout conic, tip and surface convex, basal width $1\frac{1}{4}$ its length. Eye rounded, closer to upper profile than mouth, about midway in gape of latter, and without eyelid. Mouth large, horizontal, and completely closing. Lips rather tough and fleshy, minutely papillose. Teeth conic, mostly erect, subequal, strong, edges entire, uniserial in jaws, posteriorly or laterally a little inclined backward. In upper jaw each side 5 large erect conic canines before eyes, and 2 below latter, though these a little smaller. Medianly on premaxillary region or well before eye, series of 3 enlarged conic depressible canines, last largest. Mandible with uniserial teeth, 4? enlarged erect conic canines each side in front, followed by mostly equal row of close-set backwardly directed and rather compressed teeth. No vomerine teeth now, but depressions or little concavities, which would indicate that if teeth occur they are deciduous?. No tongue. Mandible equal with snout tip in front, surface convex, rami low and strong. Front nostril in short fleshy tube, length 2 in eye. Hind nostril simple pore little before eye front. Interorbital space convex. Occipital region well swollen and bulging rather abruptly down to interorbital in profile.

Gill-opening a little below median axis in body, but little inclined from horizontal, length about $1\frac{3}{4}$ in snout. Pharynx with about a dozen deep grooves longitudinally each side and below.

Skin smooth, tough and thick, especially along bases of dorsal and anal. Along each upper lip 5 pores well above lower edge, first close before nasal tube, second close behind nasal tube, third little before middle in snout, fourth a little before front eye edge and fifth below hind eye edge. On snout above a pair of wide-set pores between nasal tubes, and another a little before third upper labial pair, well superior on snout. About 5 pores on each mandibular ramus. L. l. not evident.

Dorsal origin apparently near last fourth in space between hind eye edge and gill-opening, fin high, especially behind, where continuous with caudal. Latter rounded, length about $1\frac{2}{5}$ in eye. Anal like dorsal, only lower. Vent close before anal.

Color in alcohol deep chocolate-brown, mostly with this ground-color entirely uniform, and belly and head below scarcely paler. On back and most of trunk posteriorly, inconspicuous pale or minute grayish dots like pin-points, rather sparsely distributed. These not extending on belly or head, though on dorsal fin becoming more numerous than on body. Dorsal also with numerous oblique narrow lines of darker shade than body color, sloping up from back towards edge. Anal with several more or less complete darker longitudinal lines than ground-color of fin. Iris brownish. Mouth brownish inside. Rictus not darker than ground-color of body. Gill-openings similar. Teeth pale.

Length 27¼ inches.

Type No. 16,705, A. N. S. P. No data. (This specimen was in a jar received from E. D. Cope labelled "Texas" and may have been secured somewhere in the West Indies.)

In many respects this species resembles the larger examples of *G. funebris* in the collection, but it has no vomerine teeth, and the lips are densely papillose. Its dorsal is also more posteriorly inserted and the coloration is entirely different.

(Στίγμα, spot; νωτος, back; with reference to the dorsal spots.)

Subgenus PRIODONOPHIS Kaup.

Gymnothorax ocellatus Agassiz.

One from Santo Domingo, West Indies. This seems to agree better with Agassiz's figure, than the other examples listed below, which I formerly identified with it. Agassiz shows the white spots of uneven size, some of which about equal to pupil and others smaller, and dorsal and anal with many various white spots, of which some small and others much larger than eye, black interspaces often equally large.

Gymnothorax ocellatus saxicola Jordan and Davis.

One from New Jersey and another from Pensacola, Florida.

Eurymyctera acutirostris (Abbott).

Murœna acutirostris Abbott, Proc. Acad. Nat. Sci. Phila., 1860, p. 476. Hawaii.

No. 998, A. N. S. P., type of *M. acutirostris* Abbott.

Echidna zebra (Shaw).

One from Muscat Cove, Philippine Islands.

Echidna peli (Kaup).

Three from West Africa.

Echidna nocturna (Cope).

Pœcilophis nocturna Cope, Rep. U. S. Geol. Surv. Hayden, 1871 (1872), p. 474. Rio Grande at San Jose, Costa Rica.

No. 14,926, A. N. S. P., type of *P. nocturnus* Cope.

Echidna chionostigma sp. nov. Fig. 7.

Head, 8; depth $15\frac{1}{5}$; head width $3\frac{1}{2}$ in its length; head depth $1\frac{7}{8}$; snout 6; eye $9\frac{1}{2}$; mouth $2\frac{2}{3}$; interorbital $8\frac{2}{5}$; head $3\frac{4}{5}$ to vent.

Body moderately long, well compressed, trunk of about even depth, belly with lower surface rounded, and long tail tapering back in rather acuminate tip.

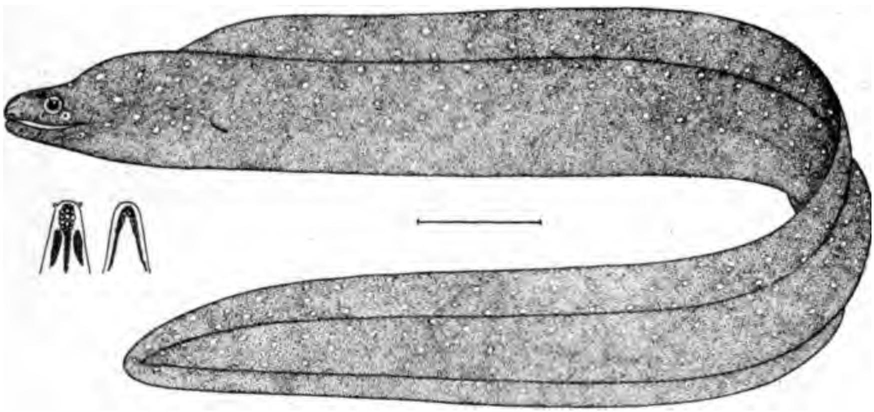

Fig. 7.—*Echidna chionostigma* Fowler. Type.

Head well compressed, upper profile rather swollen above with depression above eye otherwise like convex lower, and more or less flattened sides not especially converging above or below. Snout surface and profile convex, basal width $1\frac{1}{8}$ its length. Eye rounded, without eyelid, trifle nearer mouth corner than snout tip. Mouth nearly horizontal, not completely closing, moderate. Lips thick, fleshy, minutely papillose. Teeth mostly molar-like, upper anterior to eye largest in same jaw, these in a continuous outer series and median gradually larger series of 3, all erect and obtusely conic. On vomer teeth continued back from anterior upper teeth as an irregular double series of smaller shorter ones. In upper jaw from below front of each eye backward, a somewhat irregular double series of rather slender sharply pointed conic depressible teeth. Mandibular teeth rather short, obtuse, mostly somewhat pointed, and biserial anteriorly where approximated to upper jaw when mandible closes. No tongue. Mandible powerful, well curved,

rami rather low, symphyseal tip trifle shorter than snout tip. Front nostril in short pale tube each side of snout tip. Hind nostril in slightly elevated cutaneous rim above front eye edge. Interorbital convex.

Gill-opening inclined moderately, below median body axis, about equals eye in length. Pharynx well swollen, though not conspicuously so.

Skin smooth, tough. Along each upper lip 5 pores. On snout above 2 pairs of pores between front nasal tubes and another pair placed about midway between front and hind pairs. Along each mandibular ramus 5 pores. No l. l.

Dorsal origin last $\frac{2}{3}$ in space between hind eye edge and gill-opening, fin well elevated and continuous around tail with small rounded caudal. Latter about equals eye. Anal like dorsal, only lower. Vent close before anal.

Color in alcohol deep chocolate-brown generally, marked with small white points, well scattered, numerous, rounded and none larger than pupil. These white spots not extending on median line of abdomen or head below. Labial pores of head each situated in a white spot. Mouth corners and gill-openings pale or like surrounding coloration. Inside mouth pale. Iris pale slaty. Whitish dots on fins similar to those on body.

Length $13\frac{1}{4}$ inches.

Type No. 14,519, A. N. S. P. Probably from the Gulf of California.

Also No, 14,520, same data, paratype. Head $7\frac{7}{8}$; depth $17\frac{1}{5}$; snout $5\frac{1}{2}$ in head; eye $8\frac{1}{4}$; mouth 3; interorbital 8; head $4\frac{1}{5}$ to vent. Mouth completely closing. Anterior upper median enlarged teeth depressible. Neither of my examples show the pale dots with blackish margins.

This species resembles *Echidna nocturnus*, but differs in the longer anal. The example supposed to have been taken at Cape San Lucas by Xantus, and referred to *E. nocturnus* by Jordan and Davis, may probably be identical with the present species.

(*Χίων*, snow; *στίγμα*, spot; with reference to the spotted coloration.)

Echidna catenata (Bloch).

Three from St. Martins, West Indies. Another, very young, largely agrees with the largest in its dentition. In color many of its bands are alternately irregular, so that but few nearly complete saddle-like blotches form. Length 6 inches.

Echidna nebulosa (Ahl).

Three from Samoa, one from Hawaii, and another without data (likely from the last locality?).

Echidna polyzona (Richardson).

One from Hawaii.

Echidna zonata Fowler.

Proc. Acad. Nat. Sci. Phila., 1900, p. 495, Pl. 18, fig. 2. Hawaii.

No. 16,484, A. N. S. P., type.

Echidna sauvagei sp. nov. Fig. 8.

Head 7; depth $13\frac{2}{3}$; head width $3\frac{4}{5}$ its length; head depth $1\frac{3}{4}$; snout 6; eye 9; mouth 3; interorbital $8\frac{1}{2}$; head $3\frac{1}{4}$ to vent.

Body long, well compressed or sides with but slightly convex surfaces, trunk of about uniform depth, and tail tapering back behind moderately slender to tip.

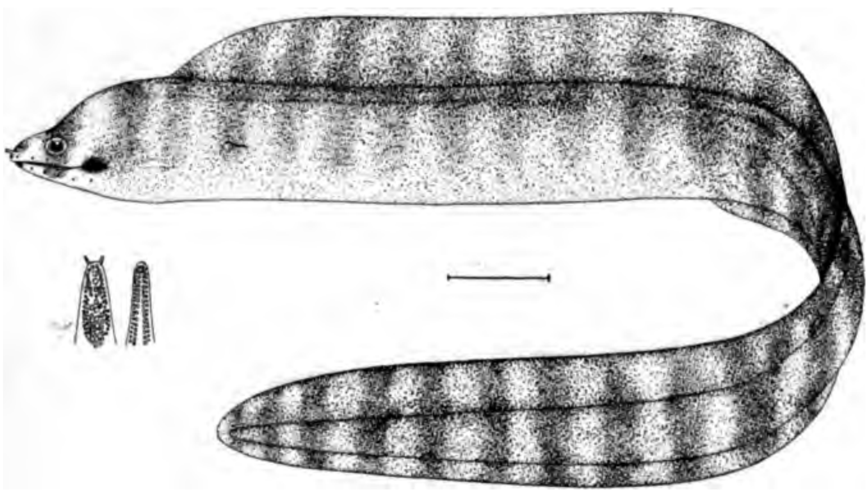

Fig. 8.—*Echidna sauvagei* Fowler. Type.

Head well compressed, rather swollen behind, lower profile more evenly convex than upper, which depressed slightly over eye, and sides not converging above or below. Snout convex over profile and surface, basal width $1\frac{1}{4}$ its length. Eye large, slightly ellipsoid, without eyelid, little behind middle in upper jaw length. Mouth nearly horizontal, commissure but slightly curving down though showing it not completely closing. Lips thick, fleshy, smooth, rather broad and largely free. Teeth all coarse, rather large, obtuse. Upper teeth little longer than others anterior to eye, latter more

conic though tips not sharp pointed, forming an erect outer series and a median series of 3 larger and partly movable broad-based ones. All vomerine region from about opposite beginning of eye backwards with series of 3, and in widest portion of area 4, of broad low convex molar-like teeth. Surface of this whole area also convex. Along sides of upper jaw, also extending well forward though rather irregularly, two rows of small and rather slender obtusely-pointed teeth, these also in places partly movable. Mandibular teeth low, molar-like, biserial, largely uniform in size, close-set, and only anterior inner series more enlarged with outer series decreasing in size. No tongue. Mandible strong, convex, curved so that only symphyseal region approximates front of upper jaw, and tip a little shorter than slightly protruding snout. Front nostril in fleshy tube each side of snout tip, length 2 in eye. Hind nostril simple pore over eye front, edge hardly elevated.

Gill-opening short and nearly horizontal slit about midway in axis of body, length about equals eye. Pharynx well swollen, surface smooth and but few slight lateral longitudinal short grooves.

Skin tough, smooth. Along each upper lip laterally 4 pores, and along each mandibular ramus 6 pores. On snout 3 pairs of pores, first at tip, second between nasal tubes and third midway in snout length. No l. l.

Dorsal origin little nearer gill-opening than mouth corner, fin high and continuous with caudal. Latter rounded, length 1½ in eye. Anal like dorsal, only lower. Vent close before anal.

Color in alcohol rich brown generally, a trifle darker above on trunk than below, though tail more unicolor. Along back about 24 transverse obscure ill-defined and slightly darker bars or bands, these not continuous across belly or only after vent. Through eye and passing over forehead and mandible medianly a deep brown transverse band though not continuous on lower surface of mandible. Another ill-defined band, though leaving a quite dusky blotch or tinge at rictus passes similarly behind latter, though including it in its course. Transverse bands also reflected on dorsal and anal. Body most everywhere on trunk, tail and fins, with more or less swarthy appearance. End of muzzle largely whitish, surface of snout above and symphyseal region of mandible slightly tinged with brownish. Edges of fins not darker, except where bands extend more or less completely. Eye pale slaty. Inside mouth whitish.

Length 15⅝ inches.

Type No. 38,164, A. N. S. P. No data (though taken from a jar

containing an example of *Echidna nebulosa*
Gymnothorax laysanus, thus likely from Ha

This example resembles *Pœcilophis tritor*
but differs in the throat not having some ho
tail a little longer than the body, the gill-c
by a more or less distinct blackish spot, and

(Named for Dr. Henri E. Sauvage, auth
butions to Ichthyology).

Echidna delicatula Jordan and Seale.

One from Apia, Samoa.

Uropterygius macrocephalus Bleeker.

Three from Apia, Samoa.

MORINGUIDÆ.

Aphthalmichthys gangeticus sp. nov. Fig. 9.

Head $10\frac{1}{2}$; depth about 53; head width
head depth about 4; snout 7; eye about 1
in head; interorbital about 2 in snout; head

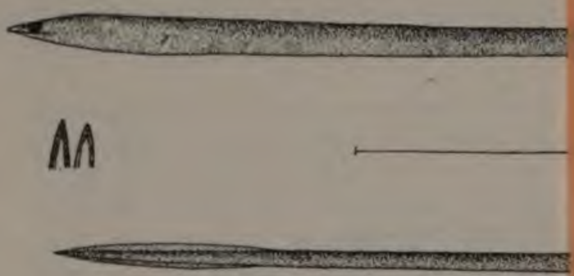

Fig. 9.—*Aphthalmichthys gangeticus* Fo

Body slender, subcylindrical, of more or le
riorly and only tapering gradually behind
compressed and attenuated.

Head with rather swollen appearance, surf
in front. Snout conic, pointed, basal width a
tip slightly projects (damaged, but restored i
physis of mandible. Eye a little ellipsoid, a l
snout tip, without eyelid. Mouth horizontal
small, conic, rather slender, biserial around
uniserial in mandible. No other teeth clear
tongue. Jaws completely closing, and rami low i

terior nostril?. Posterior nostril simple pore close before eye on side of snout. Interorbital slightly convex.

Gill-opening small, lateral, about size of eye in length? (damaged).

Skin smooth.

Dorsal and anal developed as low cutaneous folds, former beginning about opposite vent and latter close after. Both obsolete behind and in height scarcely equal to half of body-depth at that point. End of tail simple point, without any trace of caudal fin. Vent little before last eight in total length.

Color faded dull or uniform pale brownish. Eyes slaty.

Length about $5\frac{3}{4}$ inches.

Type No. 1,086, A. N. S. P. Ganges River, India. Dr. M. Burrough.

This species differs from the only other Indian species of the genus, *A. macrocephalus*, in having the vent much more posterior.

(Named for the River Ganges, somewhere in the estuary of which the species was likely secured.)

RECORDS OF FISHES FOR THE MIDDLE ATLANTIC STATES AND VIRGINIA.

BY HENRY W. FOWLER.

In this paper a list of the species obtained from each State is given, with a summary of all the localities representing material which I have not noted before. It is desirable to place these all on record as of value in geographical distribution. In preparing this article many specimens have been examined, often embracing in numbers many thousands, of which the more important were preserved for the collections of the Academy, besides others studied at the various fisheries, markets and elsewhere. Among many of the latter class one often meets with large forms undesirable for preservation, so that but few were saved. Some species were quite rare, and others at least new records for the States in which they were taken. Still others are interesting in pointing out new limits or features in their distribution. Two pelagic species, wandering to the coasts of New Jersey, are apparently new.

New York.

All the specimens from this State, listed below, were received from Mr. T. D. Keim during the past few years.[1]

Anchovia eurystole Swain and Meek.

One taken at Long Beach, Long Island, on August 20, 1911. Other fishes noted at this locality were *Raja eglanteria*, *Fundulus majalis*, *F. heteroclitus macrolepidotus*, and *Ammodytes americanus*.

Notropis bifrenatus (Cope).

Dungan Hill, Staten Island.

Fundulus majalis (Walbaum).

Hunter's Island, in Long Island Sound.

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[1] An adult *Pygosteus pungitius* and ten young *Poronotus triacanthus* from Long Island Sound near Darien, Conn., were also secured in the summer of 1910. The latter were taken from under a floating medusa.

I also have *Seserinus paru*, *Chætodipterus faber* and *Lagocephalus lævigatus* secured in August of 1907 at Nantucket, Mass., by Dr. Benjamin Sharp. These were all taken from inside the Great Point traps. Dr. Sharp has also reported a large *Tarpon atlanticus* taken at the same locality on September 30, 1909. I mention these as occasional species in the New England region of the Virginian province.

Fundulus heteroclitus macrolepidotus (Walbaum).

Hunter's Island.

Fundulus diaphanus (Le Sueur).

Hudson River in Greene Co.

Mugil cephalus Linnæus.

Four young from South Beach, Long Island, on July 16, 1911.

Seriola zonata (Mitchill).

Long Beach.

Pseudopriacanthus altus (Gill).

Young from Long Beach on August 2, 1911.

Tautogolabrus adspersus (Walbaum).

Hunter's Island.

Myoxocephalus octodecimspinosus (Mitchill).

Two very young from tide-pools at Rye Beach on May 19, 1910.

NEW JERSEY.

Squatina squatina (Linnæus).

A female about 40 inches long was secured at Sea Isle City, through Mr. W. J. Fox, on July 7, 1911. It was taken in the off-shore pounds, and known to the fishermen as "lizard fish." A large *Mola mola*, weighing about 200 pounds, was also secured at the same time, though not preserved.

Atopichthys novæ-cæsariensis sp. nov. Fig. 1.

Head about $13\frac{3}{5}$; depth about $11\frac{3}{5}$; snout about $4\frac{1}{4}$ in head, measured from upper jaw tip; eye 4; maxillary $2\frac{1}{4}$; interorbital $3\frac{1}{4}$; head depth at occiput $2\frac{1}{3}$; muscular segments about 70 + 50.

Body oblong, greatly compressed, tapering well anteriorly to region of greatest depth about third, fourth and fifth sixths of trunk length. Tail tapering rather suddenly, though less gradual than front of body.

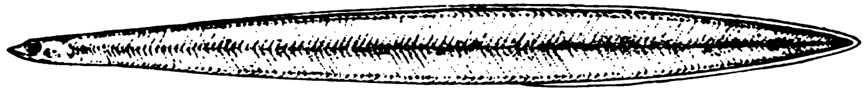

Fig. 1.—*Atopichthys novæ-cæsariensis* Fowler. Type.

Head widest part of body, slightly compressed, profiles similar. Snout conic, compressed slightly, basal width trifle greater than its length. Eye large, rounded, its hind edge about midway in head. Mouth cleft straight, extends back about opposite eye centre.

Mandible depressed, shallow, rami low, symphysis extending forward slightly before snout tip. Maxillary not distinct. Teeth long, slender, uniserial in jaws, and flaring out all around jaw edges. No teeth on palate. Tongue not distinct. Nostrils well separated small pores, on side of snout, anterior near snout tip and posterior close before eye. Interorbital a little convex.

Gill-opening small, inferior.

Body naked, smooth, myocommas and myomeres distinct.

Vertical fins low, continuous around caudal and latter less than eye. Pectoral not evident. Vent about last $\frac{2}{5}$ in total length.

Color in alcohol uniform pale brownish. Iris slaty. Along ventral edge of body 2 series of dark chromatophores, these series closely approximated, and a single chromatophore about opposite each myomere. No other chromatophores.

Length $4\frac{3}{4}$ inches.

Type No. 982, A. N. S. P. Beesley's Point, Cape May County, New Jersey. Charles E. Ashmead.

Only a single example, described above. It appears to be related to species without pectoral fins, such as *Atopichthys gillii* (Eigenmann and Kennedy) and *A. strommani* (Eigenmann and Kennedy). It is, however, much longer and more slender, with the vent different, and the muscular bands with other formula.

(Named for New Jersey.)

Atopichthys phillipsi Fowler.

Another example of this interesting fish, only known before from the type, was secured at ("Mountain Island") Corson's Inlet on June 26, 1909, by Dr. R. J. Phillips. On this occasion Dr. Phillips notes *Mustelus mustelus, Raja eglanteria, Brevoortia tyrannus, Fundulus majalis, F. heteroclitus macrolepidotus, Menidia menidia notata, Centropristis striatus, Bairdiella chrysura, Menticirrhus saxatilis, M. americanus, Sciænops ocellatus, Cynoscion regalis, Tautogolabrus adspersus, Tautoga onitis, Spheroides maculatus, Paralichthys dentatus* and *Opsanus tau.*

Felichthys marinus (Mitchill).

One taken August 11, another August 14, and still another August 20, 1911, at Corson's Inlet.

Fundulus luciæ (Baird).

Mr. W. B. Davis secured one on June 21, 1911, in the salt-ponds near Peck's Bay. It was associated with *F. heteroclitus macrolepidotus* and *Cyprinodon variegatus.* On July 22 Mr. D. McCadden

secured *Apeltes quadracus*, *Syngnathus fuscus*, *Menidia menidia notata* and *Menticirrhus saxatilis* in Peck's Bay.

Gambusia gracilis Heckel.

Abundant in tributaries of Goshen Creek, near Goshen, on October 13, 1911, where many were secured by Mr. F. Leaming and the writer. *Fundulus heteroclitus macrolepidotus* was the only species we found associated, though in the upper reaches, while *Gambusia* was absent, *Abramis crysoleucas*, *Erimyzon sucetta oblongus* and *Umbra pygmæa* were found. In Bidwell Creek we found *Anguilla chrisypa*, *F. majalis*, *F. heteroclitus macrolepidotus*, *Cyprinodon variegatus*, *Menidia beryllina cerea*, *M. menidia notata*, *Bairdiella chrysura*, *Leiostomus xanthurus*, *Micropogon undulatus* and *Pogonias cromis*. Myriads of *Palæmonetes vulgaris* were also secured. In Crooked Creek we found *A. chrisypa*, *F. heteroclitus macrolepidotus*, *F. diaphanus* and *Apeltes quadracus*.

Tylosurus raphidoma (Ranzani).

Mr. W. J. Fox secured an adult example at Sea Isle City during the past summer, besides examples of *Rachycentron canadus*, *Balistes carolinensis*, *Stephanolepis hispidus*, *Lagocephalus lævigatus*, *Alutera shæpfii*, *Lophopsetta maculata* and *Echeneis naucrates*.

Sphyræna borealis De Kay.

Dr. R. J. Phillips secured an example about 10? inches long, taken from the stomach of a blue fish (*Pomatomus saltatrix*) caught at Corson's Inlet, on September 15, 1911. Other interesting species obtained by Dr. Phillips at this locality are *Leptocephalus conger*, *Chilomycterus schæpfi*, *Rissola marginata* and a young *Pogonias cromis*.

Lepomis incisor Valenciennes.

Mr. B. H. Gledhill secured an adult in Warrington Pond, at Tomlin, on September 23, 1911.

Lyosphæra globosa Evermann and Kendall.

An example was secured at Anglesea some years ago by the late Uselma C. Smith. It is now in the collection, and in good preservation. This species has not been recorded from New Jersey before, and this is therefore evidently its most northern range.

Etropus microstomus (Gill).

Mr. W. B. Davis and the writer secured three examples of this interesting flounder on June 21, 1911, in Great Egg Harbor Bay at Ocean City. Other fishes we also found there were *Mustelus mus-*

telus, *Raja eglanteria*, *Pomolobus mediocris*, *P. pseudoharengus*, *Anchovia mitchilli*, *Fundulus majalis*, *Syngnathus fuscus*, *Menidia menidia notata*, *Trachinotus carolinus*, *Cynoscion regalis*, *Menticirrhus saxatilis*, *Lophopsetta maculata*, *Paralichthys dentatus*, *Pseudopleuronectes americanus* and *Achirus fasciatus*. This is noteworthy as all the pleuronectids were found associated.

Antennarius teleplanus sp. nov. Fig. 2.

Head (measured to axil of pectoral) about $1\frac{3}{4}$; depth about $1\frac{2}{3}$; D. I—I—I—12; A. 7; P. 11; V. 5; head width (measured to axil of pectoral) about $1\frac{2}{5}$ in its length; snout $5\frac{3}{4}$ in head, measured from median upper jaw tip to gill-opening; eye $10\frac{1}{2}$; maxillary $2\frac{2}{3}$; mandible length $2\frac{1}{2}$; mouth width at ricti $2\frac{1}{5}$; interorbital $4\frac{1}{3}$; bait about $2\frac{2}{3}$; second dorsal spine about $4\frac{1}{2}$; third dorsal spine about $3\frac{1}{5}$;

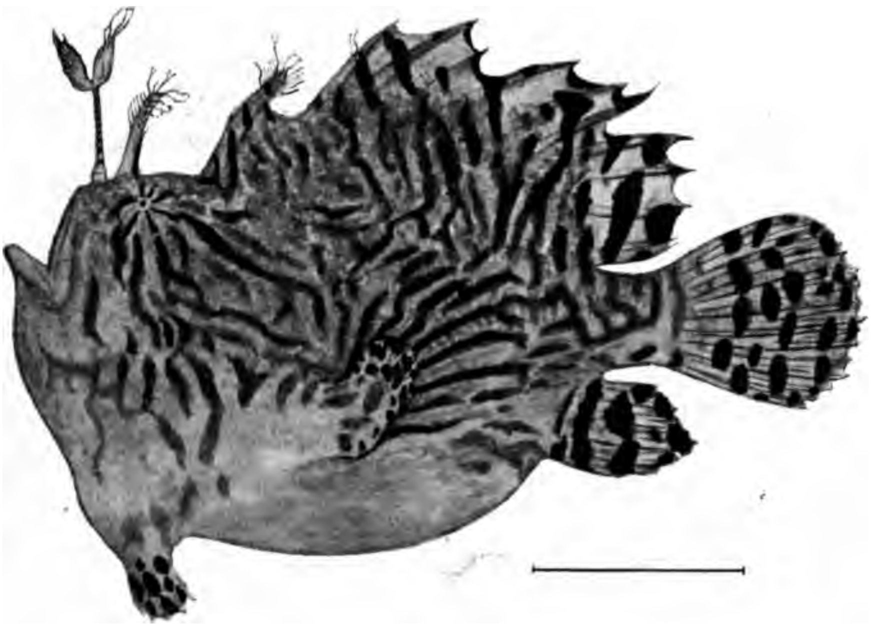

Fig. 2.—*Antennarius teleplanus* Fowler. Type.

fifth dorsal ray about 3; anal base about 4; fourth anal ray about $2\frac{7}{8}$; caudal $2\frac{1}{5}$; least depth of caudal peduncle $4\frac{2}{5}$; pectoral base $5\frac{1}{2}$; ventral base $6\frac{1}{4}$.

Body deep, well compressed, deepest at dorsal origin, back elevated with approximating surfaces, and rounded belly with swollen appearance. Caudal peduncle compressed, rather small, its length about $\frac{3}{5}$ its least depth.

Head very large, deep, and with mandible closed anterior profile nearly evenly convex. Upper surfaces approximating like those of back, and lower well swollen convexly till much wider. Snout short, little inclined from horizontal forward, length about $\frac{3}{5}$ its width. Eye small, rounded, high, lateral, anteriorly below second dorsal spine. Mouth large, wide, nearly vertical. Premaxillaries well protractile. Maxillary long, nearly vertical, its hind lower edge about opposite front eye edge, and greatest distal expansion but trifle less than eye. Upper lip thin, tough, and lower thicker though also tough. Teeth small, sharply pointed, rather slenderly conic and in rather narrow bands in jaws. No teeth on median line of mouth roof, though 2 patches of teeth, similar to those in jaws, in each palatine region. Two small patches of similar pharyngeal teeth above and 2 patches also below. Tongue large, broad, depressed, free in front and along sides, smooth, and front edge convex. Mandible not very powerful, broad, with slight symphyseal knob in front, and rami but moderately expanding at their posterior articulations. Nostrils small, obscure, about last $\frac{2}{5}$ between eye front and edge of upper jaw. Interorbital slightly convex.

Gill-opening small slit at lower pectoral base well before middle in entire length of fish.

Body very finely roughened everywhere, except at lower surfaces of pectorals and ventrals. Tubercles in many regions bifid. Tubercles on head above and l. l. anteriorly rather large, or as spinescent clusters. A smooth area on interorbital between second and third spines. Extending down along preopercular region some obscure spinescent clusters. No cutaneous flaps, or if a few present very inconspicuous. L. l. scarcely evident, except anteriorly, and even there obsolete.

Bait very slender and not extending beyond middle of third depressed dorsal spine, bulbous and bifid at end, and each division with a few short filaments. Second dorsal spine inserted close after bait, largely free, mobile, though not depressible back to origin of third dorsal spine. Latter with only end mobile, united behind for large part by broad basal membrane, and depressible spine not reaching back to origin of rayed dorsal. Soft dorsal rather high, long, its margin very unevenly gashed as some rays are inserted nearer one another than to others. Anal small, well posterior, and extending slightly further back on caudal peduncle, median rays longest with edge of fin slightly gashed in places. Caudal large, rounded behind with median rays longest. Pectoral moderate,

tips of rays projecting slightly beyond membranes. Ventrals similar, though smaller than pectorals. Vent rather conspicuous, close before anal.

Color in alcohol with ground tint dull olivaceous to yellowish, former largely above and latter obtaining below. A number of blackish or dusky narrow streaks radiate from eye, where they extend over iris to pupil. Several similar streaks radiate from upper edge of third dorsal spine. Soft dorsal with numerous black streaks, broad, and many broken into large blotches or spots, nearly vertical or slightly inclined back, and extending down on back more or less regularly till level with upper edge of caudal peduncle. Then all more inclined forward towards pectoral axilla and abdomen. Though body blotched with dusky between gill-opening and vent, no blotches on entire belly between ventrals and vent, except around latter. Anal with blackish blotches or streaks like those on soft dorsal, these in about four rows. Caudal with three distinct rows of transverse black spots or blotches, smaller than on soft dorsal and anal. Pectoral and ventral covered with large black blotches both above and below, and several obsolete ones before base of former. Bait pale, with narrow transverse blackish bars. Gill-opening pale. Tongue, and mouth inside, whitish generally, though former with dusky and blackish mottlings. Pupil pale. Most of dark blotches on all fins show along their edges a paler or more whitish shade than ground color.

Length about 4 inches.

Type No. 38,162, A. N. S. P. Corson's Inlet, Cape May County, New Jersey. Caught in the bait-net on September 30, 1911. Dr. R. J. Phillips.

Only the type known. It closely resembles *Antennarius scaber* (Cuvier), but differs in the absence of the numerous dermal body flaps, as well as the pattern of coloration shown by Valenciennes.[2] *Antennarius tigris* (Poey) is also another species closely related, though differing markedly, if Poey's figure is to be trusted. Poey shows the caudal almost entirely spotted, a row of five black spots in a slightly oblique row on anal, and bait with its bulbous end longer than basal portion, in fact reaching back to tip of first soft dorsal ray.

(*Τηλέπλάνος*, wandering far; so named as no American member of the genus ever before recorded so far north of Florida.)

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[2] *Règne Animal Cuv.*, Ed. Luxe, 1839, Pl. 85, fig. 1.

Besides the above records a few of the numerous small collections, made during the past year, in some localities where material has not been obtained before, may be of interest.

During June Mr. W. B. Davis and the writer secured the following: in Cedar Swamp Creek *Pomolobus mediocris, Alosa sapidissima, Anguilla chrisypa, Abramis crysoleucas, Fundulus heteroclitus macrolepidotus, F. diaphanus, Mugil curema, Eupomotis gibbosus* and *Morone americana;* in a tributary of the Tuckahoe River at Johnson's Mill, *Pomolobus mediocris, Abramis crysoleucas, Ameiurus natalis prosthistuis, Fundulus heteroclitus macrolepidotus, F. diaphanus, Esox americanus, E. reticulatus, Aphredoderus sayanus, Mesogonistius chætodon, Enneacanthus gloriosus* and *Boleosoma nigrum olmstedi;* a tributary of the Tuckahoe River at Wallace's Mill, *Notropis chalybœus abbotti, Erimyzon succetta oblongus* and *Boleichthys fusiformis.*

On July 3 Mr. W. T. Innes, Jr., and the writer secured the following in Pancoast's Run, near Pancoast's Mill: *Umbra pygmæa, Esox reticulatus, Aphredoderus sayanus, Mesogonistius chætodon* and *Enneacanthus gloriosus.* On December 2 we visited Cohansey Creek at Bridgeton, in Cumberland County, and found: *Anguilla chrisypa, Abramis crysóleucas, Notropis bifrenatus, Fundulus heteroclitus macrolepidotus, F. diaphanus, Apeltes quadracus, Enneacanthus gloriosus* and *Eupomotis gibbosus.* A small "water boatman," kindly identified by Messrs. Henry Skinner and E. T. Cresson, Jr., as *Corixa brimleyi,* a North Carolina species, was secured, and is another interesting addition to the fauna of New Jersey.

An interesting collection made at Cape May Point by Mr. E. R. Brown during the past summer contained: *Sphyrna zygæna, Squalus acanthias, Raja erinacea, Pomolobus æstivalis, Brevoortia tyrannus, Anchovia mitchilli, Tylosurus marinus, Hippocampus hudsonius, Mugil cephalus, Selene vomer, Trachinotus carolinus, Pomatomus saltatrix, Centropristis striatus, Lagodon rhomboides, Leiostomus xanthurus, Menticirrhus saxatilis, Spheroides maculatus, Chilomycterus schœpfi, Prionotus evolans strigatus, Rissola marginata* and *Pseudopleuronectes americanus.* Two interesting examples of *Chloridella empusa* were also obtained, and this species was reported to be abundant.

PENNSYLVANIA.

Mr. R. W. Wehrle has collected extensively in Indiana County, forwarding many interesting collections to the Academy. The

other material has been secured by the writer largely, though often with the assistance of others whom I have acknowledged elsewhere.

Petromyzon marinus Linnæus.

Delaware River at Torresdale, Philadelphia County. I also examined a young one from Goldsboro, York County, in the possession of Mr. P. Hertzog.

Ichthyomyzon concolor (Kirtland).

Cherry Run, tributary to Crooked Run, and McKenny Run, Indiana County.

Acipenser brevirostrum Le Sueur.

Delaware River at Torresdale, Philadelphia County. I also found one at Bristol, Bucks County, on May 3, 1908.

Though I have examined examples of *A. rubicundus* at Erie and in the pounds near by, none were obtained for our collection.

Amiatus calvus (Linnæus).

Erie. A few were taken in the pounds in 1907.

Pomolobus pseudoharengus (Wilson).

Abundant in Scott's Creek, Bucks County.

Coregonus clupeaformis (Mitchill).

Erie.

Leucichthys artedi (Le Sueur).

Erie.

Salvelinus fontinalis (Mitchill).

Brandywine tributary near New Garden, Chester County; Trout Run, Lancaster County; Sugar Valley Run, Mifflin County.

Anguilla chrisypa Rafinesque.

Long Neck at Tinicum Island, Delaware County; Valley Forge and Gladwyne, Montgomery County; Neshaminy Creek near Langhorne, Bridgetown, Etterton, Long Pond, Guinea Creek, Scott's Creek, Bucks County; McCall's Ferry, Lancaster County; Juniata River at Newton Hamilton, Mifflin County.

Campostoma anomalum (Rafinesque).

McKenny, Home, Burnhamer, Rock, Saltgiver, Besnham, Broad Head, Smitten, Martin's, Mud Lick, Smicksburg, Groft's and McCormick's Runs, Ross Run and branch, Elders and Little Runs, Pickering Run and small branch, feeder to Crooked Run, Cowanshanoc, Grant and Pine Townships, tributary of North Branch of Two Lick Creek, Pine Creek and Marion Branch, Susquehanna

Creek, branches of Big and Little Mahoning and Crooked Creeks, Indiana County.

Pimephales notatus (Rafinesque).

McKenny, Home, Burnhamer, Besnham, Smitten, Martin's, Mud Lick, Smicksburg, Groft's and McCormick's Runs, Ross Run and branch, Elders and Little Runs, Pickering Run and small branch, Crooked Run and tributary, Cowanshanoc, Grant and Pine Townships, tributary of North Branch of Two Lick Creek, Pine Creek and Marion Branch, Susquehanna Creek, branches of Big and Little Mahoning and Crooked Creeks, Indiana County; Allegheny River at Foxburg, Clarion County.

I have also found it abundant in the Schuylkill River near the mouth of Mill Creek in Montgomery County. This is the most eastern locality in the State at which the species has been obtained.

Semotilus bullaris (Rafinesque).

Walton Run near Byberry, Philadelphia County; Neshaminy Creek near Langhorne, Etterton and Long Pond, Bucks County; Naylor's Run, Delaware County; Pennypack Creek near Huntingdon Valley and Walnut Hill, Montgomery County; Crum Creek near White Horse and Reese's Run, Chester County; Juniata River at Newton Hamilton, Mifflin County.

Semotilus atromaculatus (Mitchill).

Trout Creek near Centerville, Mill Creek at Gladwyne, Montgomery County; Brookfield Run, Mill Creek at Flushing, Neshaminy Creek near Etterton, Tottam Creek, Bucks County; tributary of Brandywine below Chadd's Ford Junction, Chester County.

Hacker's, Trout and Akron Runs near Ephrata, Lancaster County; Sugar Valley Run, Mifflin County; Wopsonomick Valley Run, Blair County.

Tributary of Allegheny River at Warren, Warren County; Allegheny River at Foxburg, Clarion County; Wehrle's, Simpson's, McKenny, Burnhamer, Besnham, Rock, Heilman, Smitten, Martin's, Mud Lick, Smicksburg, Groft's, McCormick's Runs, Ross Run and branch, Elders and Little Runs, Pickering Run and small branch, feeder to Crooked Run, Grant and Pine Townships, tributary of North Branch of Two Lick Creek, Pine Creek and Marion Branch, Susquehanna Creek, Branches of Crooked and Little Mahoning Creeks, Cowanshanoc, Indiana County; Castleman River at Meyersdale, Somerset County.

Leuciscus elongatus (Kirtland).

Simpson's, Cherry, McKenny, McCormick's, Mud Lick, Smicksburg, Groft's, Allen's, Home, Burnhamer, Besnham, Ross,. Rock, Saltgiver, Broad Head, Elders, Little, Crooked, Smitten, Pickering and Martin's Runs, tributary North Branch Two Lick Creek, Pine Creek and Marion Branch, Pine Township, Susquehanna Creek, branches of Ross Run and Crooked Creek, Indiana County.

Abramis crysoleucas (Mitchill).

Hunter's Run tributary to Ridley Creek and upper branch of Taylor's Run, Chester County; Long Neck at Tinicum Island, Naylor's Run, Delaware County; Gladwyne, Montgomery County; Torresdale, Philadelphia County; Guinea Creek, Bucks County.

Cocalico Creek near Denver and Swamp Bridge, Lancaster County.

Notropis bifrenatus (Cope).

Torresdale, Philadelphia County; Neshaminy Creek near Langhorne, Etterton and Long Pond, Mill Creek at Wycombe, Guinea Creek, Bucks County; Naylor's Run, Delaware County.

Notropis deliciosus (Girard).

Mr. Wehrle secured one from a tributary to Ross Run, Indiana County, in September of 1911. This species is only known from Pennsylvania waters by the previous record of Evermann and Bollman, for the Monongahela basin.

Notropis procne (Cope).

Neshaminy Creek near Etterton and Long Pond, and Mill Creek at Wycombe, Bucks County.

Notropis hudsonius amarus (Girard).

Bustleton, Philadelphia County; Neshaminy Creek near Langhorne, Bridgetown, Etterton and Long Pond, Bucks County.

Notropis whipplii analostanus (Girard).

Walton Run near Byberry, Philadelphia County; Schuylkill River near Mill Creek, Gladwyne and near-by quarry-holes, Valley Forge, Walnut Hill, Montgomery County; first and second tributaries of Brandywine below Chadd's Ford Junction, Crossart, Chester County; Neshaminy Creek near Langhorne, Etterton and Long Pond, Mill Creek at Wycombe, Scott's Creek, Bucks County.

Akron and Trout Runs near Ephrata, Lancaster County; Juniata River at Newton Hamilton, Mifflin County.

Notropis cornutus (Mitchill).

Tributary of Brandywine below Chadd's Ford Junction, Crossart, Crum Creek near White Horse, Reese's Run, Chester County;

Naylor's Run, Delaware County; Schuylkill River at Mill Creek estuary, Beth Ayres, Walnut Hill, Montgomery County; Walton Run near Byberry, Philadelphia County; Tottam Creek, Neshaminy Creek near Langhorne, Bridgetown, Etterton, Long Pond, Mill Creek at Flushing, Mill Creek at Wycombe, Bucks County; tributary of Bushkill Creek at Belfast, Northampton County.

Trout Run, Witmer's Mills and Snokestown Run, Lancaster County.

Tributary North Branch of Two Lick Creek, feeder to Crooked Run, Grant and Pine Townships, Burnhamer, Besnham, Ross, Saltgiver, Broad Head, Elders, Little, Groft's, Mud Lick, Crooked, Smicksburg, Smitten, Hileman and Pickering Runs, Susquehanna Creek, small branch of Pickering Run, branch of Big Mahoning Creek, Cowanshanoc, branch of Crooked Creek, McCormick's Run and branch of Ross Run, branch of Little Mahoning Creek, Indiana County.

Notropis rubrifrons (Cope).

Two from a small branch of Pickering Run and seventeen from a branch of Big Mahoning Creek, Indiana County. Only known from the Kiskiminitas and Monongahela basins, in Pennsylvania.

Notropis photogenis amœnus (Abbott).

Abundant in the Neshaminy Creek near Langhorne and Bridgetown, Bucks County.

Ericymba buccata Cope.

Two Lick Creek, small branch of Pickering Run, Ramsey's, Cherry, Burnhamer, Besnham, Mud Lick, Groft's, Ross, Elders, Little, Smitten and Pickering Runs, Pine Township, tributary North Branch of Two Lick Creek, branch and feeder to Crooked Run, Indiana County.

Rhinichthys atronasus (Mitchill).

Brandywine tributary below Chadd's Ford Junction, Crossart, Crum Creek near White Horse, Reese's Run, Hunter's Run tributary to Ridley Creek, Chester County; Naylor's Run, Reese's Run near Central Square, Delaware County; Walton Run near Byberry, Philadelphia County; Beth Ayres, Walnut Hill, Mill Creek at Gladwyne, Trout Run near Centerville, Montgomery County; Neshaminy Creek near Langhorne, Etterton, Long Pond, Mill Creek at Flushing, Brookfield Run, Mill Creek at Wycombe, Bucks County; tributary of Bushkill Creek at Belfast, Northampton County.

Hacker's Run near Ephrata, Cocalico Creek near Denver, Lan-

caster County; Sugar Valley Run, Mifflin County; Wopsonomick Valley Run and tributary from Kettle Reservoir, Blair County.

Tributary of Allegheny River at Warren, Warren County; Wehrle's, Cherry, McKenny, Rock, Allen's, Home, Burnhamer, Besnham, Saltgiver, Broad Head, Elders, Mud Lick, Little, Simpson, Groft's, Smitten, Pickering and Martin's Runs, Pine Creek and Marion Branch, Grant and Pine Townships. Susquehanna Creek, Cowanshanoc, branch of Big Mahoning Creek, branch of Crooked Creek, McCormick's Run, branch of Ross Run, feeder to Crooked Run, Indiana County; Castleman River at Meyersdale, Somerset County.

Exoglossum maxillingua (Le Sueur).

Abundant in the Schuylkill River near mouth of Mill Creek, Montgomery County. This is the most eastern locality in Pennsylvania where the species has been secured. Also one from Mr. O. H. Behr taken in the Loyalsock Creek near Lopez, Sullivan County.

Cyprinus carpio Linnæus.

Delaware River at Torresdale, Philadelphia County; Trout Run near Ephrata and Witmer's Mills, Lancaster County; Erie, Erie County.

Carpiodes thompsoni Agassiz.

Erie.

Catostomus commersonnii (Lacépède).

Crum Creek near Castle Rock, Hunter's Run tributary to Ridley Creek, Chester County; Naylor's Run, Delaware County; Mill Creek at Gladwyne, Beth Ayres, Walnut Hill, Valley Forge, Montgomery County; Walton Run near Byberry, Philadelphia County; Neshaminy Creek near Langhorne, Etterton, Long Pond, Mill Creek at Wycombe, Guinea Creek, Scott's Creek, Bucks County; tributary of Bushkill Creek at Belfast, Northampton County.

Trout Run near Ephrata, Lancaster County.

Castleman River at Meyersdale, Somerset County; Meadow Run near Ohio Pyle, Fayette County; Allegheny River at Foxburg, Clarion County; Wehrle's, Home, Mud Lick, Smicksburg, Groft's, Burnhamer, and Martin's Runs, Grant Township, tributary North Branch of Two Lick Creek, Pine Creek and Marion Branch, Cowanshanock, branch of Crooked Creek, McCormick's Run and branch of Ross Run, feeder to Crooked Run, Indiana County; Erie, Erie County.

Catostomus nigricans Le Sueur.

Cocalico Creek near Denver, Lancaster County; McKenny Run and tributary North Branch of Two Lick Creek, Indiana County; Neshannock River at Newcastle, Lawrence County.

Erimyzon sucetta oblongus (Mitchill).

Chester Creek near Cheney, Chester County; Walnut Hill, Montgomery County; Neshaminy Creek near Langhorne, Mill Creek at Wycombe, Guinea Creek, Bucks County; tributary of Bushkill Creek at Belfast, Northampton County; Cocalico Creek at Witmer's Mills, Lancaster County.

Moxostoma aureolum (Le Sueur).

Home, Elders, Little and Cowanshanoc Runs, branch of Big Mahoning Creek, Grant and Pine Townships, Indiana County; Erie, Erie County.

Ameiurus lacustris (Walbaum).

Erie.

Ameiurus nebulosus (Le Sueur).

Chester Creek near Cheney, Chester County; Mill Creek and quarry-holes at Gladwyne, Montgomery County; Long Neck at Tinicum Island, Delaware County; Scott's Creek, and Mill Creek at Wycombe, Bucks County; Trout Run near Ephrata and Witmer's Mills, Lancaster County; Cherry, McKenny and Simpson's Runs, Indiana County.

Noturus flavus Rafinesque.

Two Lick Creek and Cherry Run, Indiana County.

Schilbeodes gyrinus (Mitchill).

Big Neshaminy Creek at Etterton and near Long Pond, Bucks County.

Esox americanus (Gmelin).

Long Neck at Tinicum Island, Delaware County; Scott's Creek and near Penn Valley, Bucks County; Cocalico Creek at Witmer's Mills, Lancaster County.

I have examined several large examples of *E. masquinongy* at Erie, taken in Presque Isle Bay.

Umbra limi (Kirtland).

Meadeville, Crawford County.

Umbra pygmæa (De Kay).

Scott's Creek near Penn Valley and Guinea Creek, Bucks County.

Fundulus heteroclitus macrolepidotus (Walbaum).

Scott's Creek, Bucks County.

Fundulus diaphanus (Le Sueur).

Upper branch of Taylor's Run, Mill Run, tributary of Brandywine Creek below Chadd's Ford Junction, Chester County; quarry-hole near Gladwyne, Montgomery County; Neshaminy Creek near Langhorne, Etterton and Long Pond, Mill Creek at Wycombe, Scott's Creek, Bucks County.

Tylosurus marinus (Walbaum).

Delaware River at Philadelphia; Susquehanna River at Pequea, Lancaster County, in May, 1903.

Eucalia inconstans (Kirtland).

Allegheny River at Foxburg, Clarion County.

Apeltes quadracus (Mitchill).

Scott's Creek, Bucks County.

Pomoxis sparoides (Lacépède).

Delaware River at Torresdale, Philadelphia County.

Ambloplites rupestris (Rafinesque).

Cherry and Simpson's Runs, Indiana County.

Enneacanthus gloriosus (Holbrook).

Delaware River at Torresdale, Philadelphia County.

Lepomis auritus (Linnæus).

Hunter's Run, upper branch of Taylor's Run and Mill Run, tributaries of Ridley Creek, tributary of Brandywine below Chadd's Ford Junction, Chester County; Naylor's Run, Delaware County; Walton Run near Byberry, Philadelphia County; Mill Creek and Schuylkill River near Gladwyne, Walnut Hill, Montgomery County; Neshaminy Creek near Langhorne, Bridgetown, Etterton, Long Pond; Mill Creek at Wycombe, Scott's Creek, Bucks County.

Eupomotis gibbosus (Linnæus).

Chester Creek near Cheney, Chester County; Long Neck at Tinicum Island, Delaware County; Walnut Hill, Montgomery County; Neshaminy Creek near Langhorne, Bridgetown, Long Pond, Etterton, Scott's Creek, Guinea Creek, Bucks County; Akron and Trout Runs near Ephrata, Cocalico Creek near Denver, Swamp Bridge and Witmer's Mills, Lancaster County.

Micropterus dolomieu Lacépède.

Schuylkill River near mouth of Mill Creek, Montgomery County; Neshaminy Creek near Bridgetown, Bucks County; Juniata River at Newton Hamilton, Mifflin County; Erie, Erie County. I also have examined many examples of *M. salmoides* at the last locality.

Stizostedion vitreum (Mitchill).

Erie, Erie County.

Stizostedion canadense (Griffiths).

Erie.

Perca flavescens (Mitchill).

Scott's Creek, Bucks County; Erie, Erie County.

Percina caprodes (Rafinesque).

Erie.

Hadropterus macrocephalus (Cope).

Tributary to North Branch of Two Lick Creek and Mud Lick Run, Indiana County.

Boleosoma nigrum (Rafinesque).

Allegheny River at Foxburg, Clarion County; McKenny, Simpson's, Allen's, Home, Bernham, Rock, Elders, Little, Smitten, Mud Lick, Groft's, Hileman and Martin's Runs, Grant and Pine Townships, tributary North Branch of Two Lick Creek, small branch of Pickering Run, branch of Big Mahoning Creek, branch of Crooked Creek, McCormick's Run and branch of Ross Run, feeder to Crooked Run, Pine Creek and Marion Branch, Indiana County.

Boleosoma nigrum olmstedi (Storer).

Reese's Run, Crum Creek near White Horse, Hunter's Run tributary to Ridley Creek, upper branch of Taylor's Run, Mill Run, Chester Creek near Cheney, tributary of Brandywine Creek below Chadd's Ford Junction, Chester County; Naylor's Run, Delaware County; Walton Run near Byberry, Philadelphia County; Mill Creek at Gladwyne, Walnut Hill, Montgomery County; Mill Creek at Flushing, Brookfield Run, Neshaminy Creek at Etterton, Long Pond, near Langhorne, Mill Creek at Wycombe, Guinea Creek, Bucks County; tributary to Bushkill Creek at Belfast, Northampton County.

Cocalico Creek near Ephrata and Denver, Trout and Snokestown Run, Lancaster County; Sugar Valley Run, Mifflin County; Wopsonomick Valley Run, Blair County.

Etheostoma flabellare Rafinesque.

McKenny, Cherry, Simpson's, Ross, Groft's, Smitten and Hileman Runs, Pine Township, tributary North Branch Two Lick Creek, feeder to Crooked Run, Indiana County.

Roccus chrysops (Rafinesque).

Erie, Erie County.

Morone americana (Gmelin).

Scott's Creek, Bucks County.

Aplodinotus grunniens Rafinesque.

Erie.

Cottus ictalops Rafinesque.

Simpson's, Allen's, Smitten, McKenny and Cherry Runs, Susquehanna Creek, Indiana County; Meadow Run near Ohio Pyle, Fayette County.

Cottus gracilis Heckel.

Trout Run near Ephrata, Lancaster County.

Lota maculosa (Le Sueur).

Erie.

Delaware.

A few collections made during the past season, in Newcastle County, are included below.

Anguilla chrisypa Rafinesque.

West Branch of Christiana Creek (near Iron Hill, Md.).

Semotilus atromaculatus (Mitchill).

Montchanin.

Abramis crysoleucas (Mitchill).

West Branch of Christiana Creek (near Iron Hill).

Notropis whipplii analostanus (Girard).

Granogue and West Branch of Christiana Creek (near Iron Hill).

Notropis cornutus (Mitchill).

Tributaries of the Brandywine near State line, Guyencourt, and West Branch of Christiana Creek (near Iron Hill).

Rhinichthys atronasus (Mitchill).

Tributaries of the Brandywine near State line, Granogue, Guyencourt and Montchanin.

Catostomus commersonnii (Lacépède).

Guyencourt and West Branch of Christiana Creek (near Iron Hill).

Lepomis auritus (Linnæus).

West Branch of Christiana Creek (near Iron Hill).

Eupomotis gibbosus (Linnæus).

With preceding species.

Boleosoma nigrum olmstedi (Storer).

Guyencourt and West Branch of Christiana Creek (near Iron Hill).

Maryland.

Most of my own collections were made in Cecil County, while a few smaller ones are from Baltimore. In that city I have also examined many market fishes, especially those alleged to have been taken in Chesapeake Bay. Mr. E. G. Vanatta made collections at Chestertown, and Messrs. Hermann Behr and T. D. Keim at Jennings, in Garrett County.

Petromyzon marinus Linnæus.

Abundant in the spring and in early June in Clearwater Brook at Bacon Hill, tributary to the Elk River basin. In this stream I have secured many young, and also in the Little Bohemia Creek. Fishermen say lampreys are abundant in the Elk and North East Rivers and at Rock Hall.

Acipenser sturio Linnæus.

Scarce now in the Elk, North East and Susquehanna Rivers. I have seen examples in the Baltimore markets, though none now in our collections.

Lepisosteus osseus (Linnæus).

A small mounted example recently examined, though not obtained for our collection, was taken in the Elk River. This fish was rather abundant at times about the fisheries along the North East River.

Pomolobus mediocris (Mitchill).

Runs in the Elk and North East Rivers, also Little and Big Bohemia Creeks in their lower reaches. A number of examples examined at the fisheries and in the markets of Baltimore. This fish, also *P. æstivalis* and the next, are taken at Rock Hall.

Pomolobus pseudoharengus (Wilson).

Abundant in the Elk, Bohemia, North East and Susquehanna Rivers, and ascending well above tide or in the small fresh branches. The multitudes examined were from the Little Bohemia Creek, Bohemia Mills, Big Bohemia Creek, Bohemia Bridge, Elk Neck, North East, and from Chesapeake Bay (Baltimore markets).

Alosa sapidissima (Wilson.)

Runs in the larger streams, as the Elk, Bohemia, North East and Susquehanna Rivers, from all of which I have examined material. I have collected, however, only young examples in the Little and Big Bohemia Creeks, and at Elk Neck and North East. In the fishing season many fine examples may be seen exposed in the Baltimore and other markets.

Brevoortia tyrannus (Latrobe).

Patapsco River at Baltimore, Big and Little Bohemia Creeks, and Elk River at Elk Neck.

Anshovia mitchilli (Valenciennes).

Tolchester Beach.

Anguilla chrisypa Rafinesque.

North East, Stony Run, Clearwater Brook near Bacon Hill, Conewingo Creek, Little and Big Bohemia Creeks, Elk Neck and Chestertown. Numerous large ones sometimes seen in the Baltimore markets.

Hybognathus nuchalis regius (Girard).

Patapsco River at Baltimore, North East, and Fishing Creek, a tributary to Elk River near Elk Neck. Many examples, and all obtained in tidal waters.

Semotilus bullaris (Rafinesque).

Octoraro Creek near Rowlandville, Cecil County; Peddler Run, Harford County.

Semotilus atromaculatus (Mitchill).

Stony Run and tributaries of the Octoraro Creek near Porter's Bridge. Also found in the headwaters of the Castleman River near Jennings.

Leuciscus vandoisulus Valenciennes.

Very abundant in Stony Run and its small tributaries, and also found in the first tributary below emptying into the North East River. Abundant in small tributaries of the Octoraro Creek near Porter's Bridge.

Abramis crysoleucas (Mitchill).

Very common in the Big and Little Bohemia Creeks, Elk River and its tributary Fishing Creek, and also the North East River. My numerous examples from: Little Bohemia Creek, Bohemia Mills, Bohemia Bridge, Elk Neck, North East, Stony Run, Conewingo and in the Susquehanna River, Cecil County; Broad Creek, Harford County.

Notropis bifrenatus (Cope).

A few in tributaries of the Big Bohemia Creek.

Notropis procne (Cope).

Frequent in Stony Run, Cecil County.

Notropis hudsonius amarus (Clinton).

North East River at North East, and the Octoraro Creek above Rowlandville.

Notropis whipplii analostanus (Girard).

A few in Peddler Run, Harford County, and Conewingo Creek near Conewingo (estuary). Abundant at Gynn Falls near Baltimore, and in Stony Run.

Notropis cornutus (Mitchill).

Abundant at Gynn Falls near Baltimore, Stony Run, Conewingo Creek, and the Octoraro above Rowlandsville.

Notropis photogenis amœnus (Abbott).

Stony Run, and Conewingo Creek near Conewingo.

Rhinichthys atronasus (Mitchill).

Many examples from Stony Run, first tributary of North East River below Stony Run, clearwater Brook near Bacon Hill, tributaries of Big Bohemia Creek, tributaries of the Octoraro Creek near Porter's Bridge, Cecil County; Peddler Run, Harford County; headwaters of the Castleman River near Jennings, Garrett County.

Hybopsis kentuckiensis (Rafinesque).

Very abundant in Stony Run, the Conewingo Creek, the Octoraro Creek near Octoraro, above Rowlandville and near Porter's Bridge, Cecil County; Broad Creek, Harford County; headwaters of the Castleman River near Jennings, Garrett County. This species delights in rapid or turbulent foamy streams, and is a fair pan fish.

Exoglossum maxillingua (Le Sueur).

Common in Stony Run, Conewingo Creek and the Octoraro Creek above Rowlandville.

Cyprinus carpio Linnæus.

Found in the Little Bohemia Creek and Piney Creek. I have also examined many examples in the markets of Baltimore.

Catostomus commersonnii (Lacépède).

Abundant in Stony Run, Conewingo Creek near Conewingo, the Big Bohemia Creek and at Jennings.

Catostomus nigricans Le Sueur.

Stony Run and Gynn Falls.

Erimyzon sucetta oblongus (Mitchill).

Common in Clearwater Brook near Bacon Hill, Stony Run and the Big Bohemia Creek.

Ameiurus catus (Linnæus).

Many examples from North East, Elk Neck, Chestertown, Big and Little Bohemia Creeks. Many also seen in the Baltimore markets.

Ameiurus nebulosus (Le Sueur).

I have examined many examples from the Big and Little Bohemia Creeks and at North East, Cecil County. Others from Broad Creek, Harford County.

Schilbeodes gyrinus (Mitchill).

Once taken at Gynn Falls.

Schilbeodes insignis (Richardson).

Conewingo Creek near Conewingo.

Esox americanus (Gmelin).

Frequently found in Clearwater Brook, Cecil County, and Broad Creek, Harford County.

Esox reticulatus Le Sueur.

I have found it in the Little Bohemia Creek.

Umbra pygmæa (De Kay).

Abundant in Clearwater Brook, in the Big Bohemia Creek, and at Elk Neck.

Fundulus majalis (Walbaum).

Patapsco River near Baltimore, Tolchester and Chestertown.

Fundulus heteroclitus macrolepidotus (Walbaum).

Very abundant in all fresh tidal waters. My examples from the Patapsco River, Tolchester, Chestertown, Elk Neck, Fishing Creek, North East, and Big and Little Bohemia Creeks.

Fundulus diaphanus (Le Sueur).

Abundant in the Gunpowder River, Patapsco River, Big and Little Bohemia Creeks, North East, Elk Neck and Fishing Creek.

Cyprinodon variegatus Lacépède.

Tolchester and Chestertown.

Tylosurus marinus (Walbaum).

North East River at North East, Elk River at Elk Neck, and Little Bohemia Creek.

Hemiramphus brasiliensis (Linnæus).

One purchased in the Baltimore market, said to have been taken in Chesapeake Bay.

Menidia beryllina (Cope).

Abundant in the Patapsco River at Baltimore, the Big and Little Bohemia Creeks, and the Elk River at Elk Neck.

Menidia menidia notata (Mitchill).

Abundant in the Patapsco River at Baltimore and at Tolchester.

Apeltes quadracus (Mitchill).

Found in the Gunpowder River, the Big Bohemia River and Fishing Creek, the latter a tributary of the Elk River below Elk Neck.

Scomberomorus maculatus (Mitchill).

Specimens examined in the Baltimore markets were said to have been taken in Chesapeake Bay.

Selene vomer (Linnæus).

Included as Mr. T. D. Keim assures me he has examined 4 examples secured at Rock Hall several years ago.

Pomatomus saltatrix (Linnæus).

Many examined in the Baltimore markets.

Enneacanthus gloriosus (Holbrook).

Little Bohemia Creek and Chestertown.

Lepomis auritus (Linnæus).

North East Creek, Conewingo Creek, Octoraro Creek near Rowlandville, Little Bohemia Creek, Fishing Creek tributary to Elk River near Elk Neck, and Stony Run.

Eupomotis gibbosus (Linnæus).

Big and Little Bohemia Creeks, North East, Elk Neck, Fishing Creek, and Stony Run.

Micropterus dolomieu Lacépède.

Little Bohemia Creek.

Perca flavescens (Mitchill).

Big and Little Bohemia Creeks, North East, Fishing Creek near Elk Neck, and Octoraro Creek near Rowlandville. Many examples in the Baltimore markets.

Boleosoma nigrum olmstedi (Storer).

Patapsco River at Baltimore, Big Bohemia Creek, Stony Run, Conewingo Creek, Octoraro Creek near Rowlandville, and tributaries near Porter's Bridge.

Roccus lineatus (Bloch).

Found in the Big and Little Bohemia Creeks at North East. I have examined many in the Baltimore markets from Chesapeake Bay.

Morone americana (Gmelin).

Big and Little Bohemia Creeks, Bohemia Mills, North East and Elk Neck. Many Chesapeake Bay examples seen in the Baltimore markets.

Archosargus probatocephalus (Walbaum).

Several large ones seen in the Baltimore markets said to have been taken in Chesapeake Bay, likewise many examples of the next species.

Cynoscion nebulosus (Cuvier).

Leiostomus xanthurus Lacépède.

Many from the Big and Little Bohemia Creeks, Tolchester, Patapsco River at Baltimore, and others in the Baltimore markets from Chesapeake Bay.

Micropogon undulatus (Linnæus).

Many from Chesapeake Bay in the Baltimore markets.

Tautoga onitis (Linnæus).

Young in the Patapsco River at Baltimore.

Cottus ictalops (Rafinesque).

Headwaters of the Castleman River at Jennings.

Cottus gracilis Heckel.

Stony Run.

Pseudopleuronectes americanus (Walbaum).

Several from Chesapeake Bay in the Baltimore markets.

Achirus fasciatus Lacépède.

Big Bohemia Creek.

VIRGINIA.[3]

Several collections were made at Watchapreague, in Accomac County, in May of 1911. The Academy is also indebted to Mr. T. M. Milliner for additional material from this region. Besides these I have examined many species in the Norfolk market and at the fisheries at Virginia Beach in 1909. All with the * are from off Cedar Island.

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[3] An interesting collection of fishes was obtained in the Cape Fear River region of North Carolina in May of 1908 by Dr. H. A. Pilsbry. *Fundulus nottii* (Ag.), *Gambusia gracilis* Heck. and *Heterandria formosa* Ag. are from the Greenfield mill-pond at Wilmington. The following are all from Southport. *Anguilla chrisypa* Raf., *Mugil cephalus* Linn., *Trachinotus carolinus* (Linn.), *Chænobryttus gulosus* (Cuv.), *Lepomis punctatus* (Val.), *L. incisor* (Val.), *Eupomotis gibbosus* (Linn.), *Micropterus salmoides* (Lac.), *Perca flavescens* (Mitch.), *Centropristis striatus* (Linn.), *Orthopristis chrysopterus* (Linn.), *Hæmulon plumieri* (Lac.), *Otrynter caprinus* (Bean), *Calamus leucosteus* Jord., *Diplodus holbrookii* (Bean), *Cynoscion nebulosus* (Cuv.), *Bairdiella chrysura* (Lac.), *Leiostomus xanthurus* Lac., *Micropogon undulatus* (Linn.) and *Paralichthys lethostigmus* Jord. Gilb. *Lepomis punctatus* was previously only known from South Carolina to Florida.

***Petromyzon marinus** Linnæus.

***Mustelus mustelus** (Linnæus).

***Raja erinacea** Mitchill.

Large examples of *Acipenser sturio* examined at Watchapreague and Cedar Island, though none preserved.

Anguilla chrisypa Rafinesque.

Young found on Parmores Island and others, besides adults, in Locustville Branch.

***Pomolobus mediocris** (Mitchill).

***Pomolobus pseudoharengus** (Wilson).

***Alosa sapidissima** (Wilson).

Many examples of *Opisthonema oglinum* examined at Virginia Beach.

***Brevoortia tyrannus** (Latrobe).

Virginia Beach.

Umbra pygmæa (De Kay).

Common in upper still reaches of Locustville Branch. *Esox americanus* was also found in the same place, though no examples preserved.

Fundulus majalis (Walbaum).

Watchapreague Inlet and about Parmores Island.

Fundulus heteroclitus macrolepidotus (Walbaum).

Watchapreague, Cedar and Parmores Islands, tidal reaches of Locustville Branch and Virginia Beach.

Fundulus diaphanus (Le Sueur).

Locustville Branch just above tide.

Fundulus luciæ (Baird).

I found it in small numbers in the little pools on Parmores Island, associated with equal numbers of *F. heteroclitus macrolepidotus*. Many were in high coloration. None were found associated with *Gasterosteus*. I also found this species abundant in fresh pools, near the edge of the salt marsh, in the lower basin of Locustville Branch. In this place they were associated with *Cyprinodon*.

Cyprinodon variegatus Lacépède.

Cedar and Parmores Islands, and lower basin of Locustville Branch. Virginia Beach.

Lucania parva (Baird).

Common in fresh or brackish pools of Parmores Island.

Gambusia gracilis Heckel.

Found in fresh pools, near the sea, at Virginia Beach. Abundant in the fresh-water ditches in the lower basin of Locustville Branch.

Menidia menidia notata (Mitchill.)

Watchapreague Inlet.

Gasterosteus aculeatus Linnæus.

Very abundant in purely fresh-water lagoons on Parmores Island, and found associated only with *Cyprinodon*. All were quite small, and many of the males with bright scarlet axillary ventral membranes, otherwise the coloration mostly olive-green. This is the most southern locality at which I have obtained this species, and it is also noteworthy that all the individuals were so dwarfed.

Syngnathus fuscus Storer.

Watchapreague Inlet.

***Scomber scombrus** Linnæus.

I have also examined many examples of the following in the Norfolk markets: *Sarda sarda*, *Scomberomorus maculatus*, *Seriola lalandi*, *Pomatomus saltatrix*, *Seserinus paru*, *Poronotus triacanthus*, *Lobotes surinamensis*, *Archosargus probatocephalus*, *Cynoscion regalis*, *C. nebulosus*, *Sciænops ocellatus*, *Leiostomus xanthurus*, *Micropogon undulatus*, *Pogonias cromis*, and *Paralichthys dentatus*. Almost all these were said to have been captured in the pounds in Hampton Roads. At Virginia Beach I found: *Sarda sarda*, *Trichiurus lepturus*, *Seriola lalandi*, *Seserinus paru*, *Poronotus triacanthus*, *Cynoscion regalis*, *C. nebulosus*, *Bairdiella chrysura*, *Leiostomus xanthurus*, *Micropogon undulatus*, *Alutera schœpfii*, *Chilomycterus schœpfi*, and *Lophius piscatorius*.

***Pomatomus saltatrix** (Linnæus).

***Poronotus triacanthus** (Peck).

Aphredoderus sayanus (Gilliams).

Locustville Branch.

Eupomotis gibbosus (Linnæus).

Locustville Branch.

Morone americana (Gmelin).

Locustville Branch.

***Orthopristis chrysopterus** (Linnæus).

Parmores Island.

***Stenotomus chrysops** (Linnæus).

***Lagodon rhomboides** (Linnæus).

***Cynoscion regalis** (Schneider).

Parmores Island.

***Bairdiella chrysura** (Lacépède).

Parmores Island.

I have found *Leiostomus xanthurus* at Old Point Comfort.

***Micropogon undulatus** (Linnæus).

***Menticirrhus americanus** (Linnæus).

Parmores Island.

Pagonias cromis and *Sciænops ocellatus* frequently taken off Cedar Island and brought to Watchapreague, where I examined many.

***Tautoga onitis** (Linnæus).

***Sphæroides maculatus** (Schneider).

Parmores Island.

***Chilomycterus schœpfi** (Walbaum).

I have also found *Alutera schœpfii* at Hampton Roads.

***Prionotus evolans strigatus** (Cuvier).

***Lophopsetta maculata** (Mitchill).

***Paralichthys dentatus** (Linnæus).

***Opsanus tau** (Linnæus).

Also at Hampton Roads.

***Merluccius bilinearis** (Mitchill).

***Lophius piscatorius** Linnæus.

FIXATION OF SINGLE TYPE (LECTOTYPIC) SPECIMENS OF SPECIES OF AMERICAN ORTHOPTERA.[1]

SECTION ONE.

BY JAMES A. G. REHN AND MORGAN HEBARD.

The majority of present-day workers in systematic zoology are in accord on matters tending toward fixity of specific names, one of the most important of these being the limitation of the specific name to a single type specimen in cases where the original author had extensive series which he had considered typical, but of which no single type individual was selected. It not infrequently happened in such cases that two or more species were confused by the author, and the limitation of the name to one of the components is necessary for intelligible work.

In the distributional and taxonomic work on Orthoptera in which the authors are engaged, the necessity for single type (lectotypic) fixations has become imperative, and after due consideration and examination of the type series and study of the context of the original descriptions, we have made the following fixations.

In the few cases where the specific names have already been restricted or types already properly selected, such action has been followed unreservedly unless the author restricting the name has applied it to a form not represented in the original cotypic series. In the case of proper previous limitations of names we have selected types in accord with such work.

In the ensuing papers the species will be treated in groups, using as divisions the titles of the various papers whose components are considered in the subsequent pages.

Although the selection of a single type was recommended by the last International Entomological Congress, no rules have as yet been adopted governing such selections. It seems to us to be obvious that under the present conditions certain logical methods should be followed in selecting the type, but not so rigidly that special cases which are found should not receive special treatment.

[1] In papers where other than North American species are treated it has seemed best for the unity of the work to fix such exotic types as well.

In fixing the types of the species of Orthoptera described in the papers treated below we follow the law of line priority, designating from the original series a specimen from the first locality mentioned, except where other factors are found to be of greater importance, the most important of which may be stated as follows:

1. Preference is given to the sex which shows the greater amount of differentiation.

2. A figured specimen is selected in cases where this specimen can be located with certainty and no faulty work is involved.

3. In cases where the first record or records given are too general, doubtful or erroneous in character, a cotype from the first definite and unquestionably authentic locality is selected.

Where a specimen would be selected as type in accordance with the above rules, but is found to be in a badly damaged condition or known to be either destroyed or lost, preference in the selection will be given the next available individual of the typical series.

The nomenclature given will be that of the original description, as these papers are not intended to be at all revisionary.

I. "New North American Acrididæ, Found North of the Mexican Boundary," by Lawrence Bruner. (Proc. U. S. Nat. Mus., Vol. 12, pp. 47–82, Pl. I, 1889.)

The specimens, on which the species described in the paper under consideration were based, are now to be found almost wholly in the United States National Museum and the Hebard Collection, the junior author having recently acquired from Professor Bruner his entire North American Collection of Orthoptera. The types themselves are divided between the two collections, as a small part of the material originally belonged to the United States National Museum, the rest to Professor Bruner. The author did not give the exact location of any of the material, leaving it understood that part was in his own collection and part in that of the National Museum.

The labelling of specimens treated in this paper is not uniform, in most cases the entire series of specimens of a new species was labelled "TYPE" by the author, but in a few instances no type labels whatever were written.

In the present paper we are unable to use the plate of figures, except in the case of the unique figured ♂ *Pedioscertetes pulchella*, owing to the fact that the author has given us no means of determining which specimen or specimens were used for figures, except in the single case here stated. All the specimens treated in this

paper, except those which were subsequently sent to McNeill, and the missing type of *Trimerotropis thalassica*, have been examined.

MESOPS CYLINDRICUS (p. 48).

Based on an unspecified number of specimens of both sexes from two localities.

Single type here designated: ♂; Valentine, Nebraska (along the north side of Keya Paha Creek)[2], [August 10th]; (L. Bruner); Hebard Collection, ex Bruner.

DRACOTETTIX MONSTROSUS (p. 50).

Based on two specimens of both sexes from the same locality.

Single type here designated: unique ♂; Los Angeles, California, March 5th; Coquillett; Hebard Collection, ex Bruner.

OCHRILIDIA (?) CRENULATA (p. 51).

Based on an unspecified number of specimens of both sexes from numerous localities.

Single type here designated: ♂; [Ft. Robinson],[3] northwest Nebraska, [August, 1888]; (L. Bruner); Hebard Collection, ex Bruner.

OCHRILIDIA (?) CINEREA (p. 52).

Based on an unspecified number of specimens of both sexes from a number of localities.

Single type here designated: ♂; Ft. McKinney, Wyoming, [July, 1883]; (L. Bruner); Hebard Collection, ex Bruner.

MERMIRIA TEXANA (p. 53).

Based on an unspecified number of specimens of both sexes from two localities.

Single type here designated: ♂; El Paso, Texas, [November, 1887]; (L. Bruner); Hebard Collection, ex Bruner.

MERMIRIA MACULIPENNIS (p. 54).

Based on an unspecified number of specimens of both sexes from two localities.

Single type here designated: ♀; San Antonio, Texas, June; M. Newell; Hebard Collection, ex Bruner.

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[2] The use of parentheses here is to show such data as is contained in the original description and not on the specimen; the use of brackets indicates information found on the specimen but not contained in the original description.

[3] *Vide* Bruner in Rehn and Hebard, Proc. Acad. Nat. Sci. Phila., p. 140, 1910.

SYRBULA ACUTICORNIS (p. 55).

Based on three female specimens from one locality.

Single type here designated: ♀; Southwestern Texas; F. G. Schaupp; Hebard Collection, ex Bruner.

ERITETTIX VARIABILIS (p. 56).

Based on an unspecified number of specimens [of both sexes] from one locality.

Single type here designated: ♂; Silver City, New Mexico, (May); C. H. Marsh; U. S. N. M. Collection.

ERITETTIX ABORTIVUS (p. 56).

Based on an unspecified number of specimens of both sexes from two localities.

Single type here designated: ♂; Washington County, Texas, (April); (L. Bruner); Hebard Collection, ex Bruner.

BOÖTETTIX ARGENTATUS (p. 58).

Based on "numerous specimens" of both sexes from four localities.

Single type here designated: ♂;[4] Lerdo, Durango, Mexico, November; (L. Bruner); Hebard Collection, ex Bruner.

PEDIOSCERTETES PULCHELLA (p. 60).

Based upon a single pair from the same locality.

Single type here designated: unique ♂; Birch Creek, Idaho, August, 1883; L. Bruner; U. S. N. M. Collection.

PSOLOESSA BUDDIANA (p. 61).

Based on two female specimens from one locality.

Single type here designated: ♀; Carrizo Springs, Texas, June, [1885]; A. Wadgymar; Hebard Collection, ex Bruner.

PSOLOESSA ? EUROTIÆ (p. 62).

Based on an unspecified number of specimens of both sexes from one locality.

Single type here designated: ♂; Laramie River (just inside the Colorado line), July, 1883; (L. Bruner); Hebard Collection, ex Bruner.

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[4] Owing to the fact that the specimens from the first localities given in the original description have been discolored by immersion in alcohol, we have selected as type a specimen from the first definite locality represented by perfect material.

ARPHIA SAUSSUREANA (p. 63).

Based on "a large series" of specimens of both sexes from one locality.

Single type here designated: ♂; Hills lying back of San Francisco, California, late October, [1887]; (L. Bruner, Koebele); Hebard Collection, ex Bruner.

AULOCARA SCUDDERI (p. 63).

Based on an unspecified number of specimens of both sexes from many localities.

Single type here designated: ♀; [Ft. Robinson], Nebraska, [August, 1888]; (L. Bruner); Hebard Collection, ex Bruner.

MESTOBREGMA PULCHELLA (p. 64).

Based on an unspecified number of specimens of both sexes from the Yellowstone Valley.

Single type here designated: ♂; Glendive, Montana (below the mouth of the Powder River), (L. Bruner); Hebard Collection, ex Bruner.

CONOZOA TEXANA (p. 65).

Based on an unspecified number of specimens of both sexes from one locality.

Type designated by McNeill, Proc. U. S. N. M., Vol. XXIII, p. 406, 1901.

"One male (type), El Paso, Texas, G. W. Dunn, collector; Bruner Collection."

This specimen, together with all others sent to McNeill for his "Revision of the Genus Trimerotropis," has not been returned to the collection from which it was borrowed.

CONOZOA ALBOLINEATA (p. 66).

Described from a single male specimen from Los Angeles, California, Coquillett, collector; Bruner Collection. Sent to McNeill.

CONOZOA KOEBELEI (p. 67).

Described from a single male specimen from Placer County, California, September, Koebele, collector; Bruner Collection. Sent to McNeill.

TRIMEROTROPIS CYANEIPENNIS (p. 68).

Based on "numerous specimens both male and female" from one locality.

Single type here designated: ♂; Near the mouth of Ogden Canon, on the upper shore line of ancient Lake Bonneville, Salt Lake Valley, Utah, [September, 1883]; (L. Bruner); Hebard Collection, ex Bruner.

TRIMEROTROPIS AZURESCENS (p. 69).

Based on an unspecified number of specimens of both sexes from four localities.

Single type here designated: ♀; Alkali Stage Station (Green River), Wyoming, [Elevation 6,000 feet, July 27, 1877]; (S. H. Scudder); Hebard Collection, ex Bruner. This is the only specimen in the U. S. N. M. or Bruner Collection at present with locality agreeing exactly with any of those given in the original description.

TRIMEROTROPIS BIFASCIATA (p. 70).

Based on an unspecified number of specimens of unstated sex from one locality.

Type designated by McNeill, Proc. U. S. N. M., Vol. XXIII, p. 419, 1901.

"One male, without locality, Bruner Collection." As the original description includes but one locality, Los Angeles, California (Coquillett), it is natural to suppose that this specimen marked type by Bruner came from that locality.

TRIMEROTROPIS CALIFORNICA (p. 71).

Based on two males and one female from one locality.

Single type here designated: ♂; San Louis Valley, California; Coquillett; Hebard Collection, ex Bruner.

TRIMEROTROPIS MODESTA (p. 72).

Based on two female specimens from one locality.

Type designated by McNeill, Proc. U. S. N. M., Vol. XXIII, p. 426, 1901.

"One female, Silver City, New Mexico, Bruner's Type, Hebard Collection, ex Bruner."

TRIMEROTROPIS THALASSICA (p. 72).

Based on an unspecified number of specimens of both sexes from one locality.

Single type here designated: ♂; Los Angeles, California, September–October; Koebele; U. S. N. M. Collection. Missing.

TRIMEROTROPIS PACIFICA (p. 73).

Described from a single male specimen from Los Angeles, California, Coquillett, collector; Bruner Collection. Sent to McNeill.

Trimerotropis perplexa (p. 74).

Based on four males and seven females from one locality.

Single type here designated: ♀; Bad lands five or six miles to the north of Chadron, Nebraska, August, [1888]; (L. Bruner); Hebard Collection, ex Bruner.

Circotettix lapidicolus (p. 75).

Based on an unspecified number of specimens of both sexes from one locality.

Single type here designated: ♂; Salmon City, Idaho (Salmon River Range west of the place), [August, 1883]; (L. Bruner); Hebard Collection, ex Bruner.

Circotettix shastanus (p. 76).

Described from a single male specimen from Hazel Creek, Shasta County, California, August, 1885; Behrens; U. S. N. M. Collection.

Œdipoda (?) occidentalis (p. 77).

Based on an unspecified number of specimens from one locality.

Single type here designated: ♂; High stony hilltops to the southwest of San Francisco, California, late October, [1887]; (Koebele, L. Bruner); Hebard Collection, ex Bruner.

Thrincus (?) aridus (p. 78).

Based on an unspecified number of specimens of both sexes from one locality.

Single type here designated: ♂; Arid slopes back of Albuquerque, New Mexico, May [22, 1883]; (L. Bruner); Hebard Collection, ex Bruner.

Thrincus (?) maculatus (p. 79).

Based on four female specimens from one locality.

Single type here designated: ♀; Needles, California; Wickham; Hebard Collection, ex Bruner.

Haldemanella robusta (p. 81).

Based on two males and two females from one district.

Single type here designated: ♂; [Southwestern] Arizona; G. W. Dunn, Rivers; dried alcoholic specimen in Hebard Collection, ex Bruner.

II. "THE NORTH AMERICAN CEUTHOPHILI," by Samuel Hubbard Scudder. (Proc. American Academy of Arts and Sciences, Vol. XXX, pp. 17–113, 1894.)

The specimens on which the species described in the present paper were based were gathered together from many sources by Mr. Scudder. The majority of these specimens became the property of Mr. Scudder, so that in choosing the lectotypic specimens we find twenty-six in the Collection of the Museum of Comparative Zoology, all but four being from the Scudder Collection. Of the remaining thirteen species described from material not in the Scudder Collection the lectotypes have been found to be in the following collections; nine in the Hebard Collection, ex Bruner; two in the United States National Museum Collection, and two are in the possession of H. Garman, Agr. Exp. Sta., University of Kentucky.

The labelling of specimens treated in this paper is rather uniform. All of the specimens examined and recorded, with but few exceptions, are labelled "Scudder's Type, 1894." The result is that such a label signifies only that the specimen, if belonging to a species described as new in the paper under consideration, is one of the typical series.

After each reference in the paper under consideration the collection to which the material belonged is given in parentheses, but where no parentheses are to be found it is understood that the material belonged to Mr. Scudder himself. In quite a few cases, however, where there are no parentheses the material did not belong to Mr. Scudder. After the publication of this paper a very complete series was sent to Professor Bruner, all the species being represented of which Mr. Scudder had more than two specimens.

All but two of the specimens chosen as lectotypes in the present paper have been examined by the authors.

There are no figures in the paper now before us and no general statement is made in regard to the sources of the material used or the location of the types.

CEUTHOPHILUS VARIEGATUS (p. 31).

Based on two pairs from three localities.

Single type here designated: ♂; Matamoras, Tamaulipas, Mexico; L. B. Couch; Scudder Collection.

CEUTHOPHILUS LATEBRICOLA (p. 37).

Described from four male and six female specimens from five localities.

Single type here designated: ♂; Washington, District of Columbia; Wright; Scudder Collection.

Ceuthophilus grandis (p. 38).

Described from one male and two females from a single locality.

Single type here designated: unique ♂; Chattanooga, Tennessee; J. W. Martin; U. S. N. M. Collection.

Ceuthophilus secretus (p. 39).

Based on six males and two females from one locality.

Single type here designated: ♂; Dallas, Texas; Boll; Scudder Collection.

Ceuthophilus palmeri (p. 40).

Described from fourteen pairs taken in three localities.

Single type here designated: ♂; from darkest recesses of side caverns of a bat cave, Georgetown, Williamson County, Texas; E. Palmer; Scudder Collection.

Ceuthophilus corticicola (p. 41).

Based on five males and two females from two localities.

Single type here designated: ♂; Dallas, Texas; Boll; Hebard Collection, ex Bruner.[5]

Ceuthophilus varicator (p. 42).

Based on a pair from the same locality.

Single type here designated: unique ♂; Waco, Texas, July 13; Mus. Comp. Zool. Collection.

Ceuthophilus seclusus (p. 45).

Based on three males and seven females from three localities.

Single type here designated: ♂; Dallas County, Iowa, August 6; J. A. Allen; Scudder Collection.

Ceuthophilus terrestris (p. 46).

Based on a series of eleven males and five females from thirteen localities.

Single type here designated: ♂; Nahant, Massachusetts[6]; A. Agassiz; Mus. Comp. Zool. Collection.

Ceuthophilus celatus (p. 48).

Described from three males and five females from five localities.

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[5] There are no males of this species in the Scudder Collection.

[6] All other males in the series of specimens on which the description was based are much less perfect.

Single type here designated: ♀; Shasta County, California; Behrens; [1885]; Hebard Collection, ex Bruner.[7]

CEUTHOPHILUS ARIZONENSIS (p. 52).

Based on three males and nine females from two localities.

Single type here designated: ♂; Prescott Mountain District, Central Arizona[8]; E. Palmer; Scudder Collection.

CEUTHOPHILUS UNIFORMIS (p. 53).

Described from five males and nine females taken in three localities.

Single type here designated: ♂; Plains of Northern New Mexico, eastern slope, October 14; Hebard Collection, ex Bruner.[9]

CEUTHOPHILUS HEROS (p. 54).

Described from three males and two females from North Carolina.

Single type here designated: ♂; North Carolina, in old hollow tree; H. K. Morrison; Scudder Collection.

CEUTHOPHILUS CÆCUS (p. 60).

Based on one male and two females from the same locality.

Single type here designated: unique ♂; Lexington, Kentucky, June 28; S. Garman; property of H. Garman, Agr. Exp. Sta., University of Kentucky.

CEUTHOPHILUS NIGRICANS (p. 61).

Based on a pair from the same locality.

Single type here designated: unique ♂; Tyrone, Kentucky, April 23; S. Garman; property of H. Garman, Agr. Exp. Sta., University of Kentucky.

CEUTHOPHILUS FUSIFORMIS (p. 62).

Described from a unique male; Lincoln, Nebraska; (L. Bruner); Hebard Collection, ex Bruner.

CEUTHOPHILUS SALLEI (p. 63).

Described from a series of one male and seven females from a single locality.

Single type here designated: unique ♂; New Orleans, Louisiana; Auguste Sallé; Scudder Collection.

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[7] There are no adults of this species in the Scudder Collection.

[8] Owing to the name given by Scudder to this species, it would seem best not to choose as lectotype a specimen from the first locality mentioned in the original description.

[9] There are no specimens of this species in the Scudder Collection with more data than "Colorado"; these cannot with certainty be considered to be of the typical series.

Ceuthophilus meridionalis (p. 66).

Based on a unique male; Chihuahua, Mexico; Scudder Collection.

Ceuthophilus neglectus (p. 67).

Based on thirty-one males and twenty-nine females from thirteen localities.

Single type here designated: ♂; Ithaca, New York; Comstock; Scudder Collection.

Ceuthophilus tenebrarum (p. 70).

Described from seven males and four females from five localities.

Single type here designated: ♂ [10]; Bee Spring, Kentucky, June; Sanborn; Mus. Comp. Zool. Collection.

Ceuthophilus bicolor (p. 72).

Described from a unique male; Bee Spring, Kentucky, June 14; F. G. Sanborn; Mus. Comp. Zool. Collection.

Ceuthophilus valgus (p. 74).

Based on six males and three females from two localities.

Single type here designated: ♂; Colorado, Elevation 7,000–8,000 feet; H. K. Morrison; Scudder Collection.

Ceuthophilus occultus (p. 77).

Described from one male and two females from Georgia.

Single type here designated: ♀; Georgia; Morrison; Scudder Collection.

Ceuthophilus alpinus (p. 78).

Based on two pairs from two localities.

Single type here designated: ♂; South Park, Colorado, Elevation 8,000–10,000 feet, August 11-16, [1877]; S. H. Scudder; Scudder Collection.

Ceuthophilus bruneri (p. 79).

Based on four males and five females from four localities.

Single type here designated: ♀; Lincoln, Nebraska, [September, 1888]; (L. Bruner); Hebard Collection, ex Bruner.

Ceuthophilus mexicanus (p. 82).

Described from six males from two localities.

Single type here designated: ♂; San Pedro, Coahuila, Mexico, May 20; Scudder Collection.

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[10] This male is in much the most satisfactory condition of the specimens in the type series.

CEUTHOPHILUS CRASSUS (p. 85).

Based on one male and three females from an unknown locality.

Single type here designated: unique ♂; Scudder Collection.

CEUTHOPHILUS PINGUIS (p. 86).

Based on four males from a single locality.

Single type here designated: ♂; Eagle Pass, Texas; C. O. Schott; Scudder Collection.

CEUTHOPHILUS INQUINATUS (p. 87).

Based on two males and one female from two localities.

Single type here designated: ♂; Fairbury, Nebraska, [September, 1892]; Dr. Eaton; Hebard Collection, ex Bruner.

CEUTHOPHILUS DISCOLOR (p. 88).

Described from a pair from different localities.

Single type here designated: unique ♂; West Point, Nebraska, [September, 1880]; L. Bruner; Hebard Collection, ex Bruner.

CEUTHOPHILUS VINCULATUS (p. 91).

Described from four males and one female from two localities.

Single type here designated: ♂; Fort Benton, Montana, Northern Pacific Railroad Survey below Lake Jessie; Dr. Suckley; Scudder Collection.

CEUTHOPHILUS TESTACEUS (p. 92).

Based on two pairs from three localities.

Single type here designated: ♂; West Point, Nebraska, [October]; from L. Bruner; Hebard Collection, ex Bruner.

CEUTHOPHILUS LATIPES (p. 95).

Described from a unique male; Sierra de San Miguelito, Mexico; E. Palmer; Scudder Collection. (This specimen is half destroyed.)

CEUTHOPHILUS HENSHAWI (p. 97).

Described from seven males and six females from six localities.

Single type here designated: ♂; Sausalito (*nec* Sanzalito), California; H. K. Morrison; Scudder Collection.

CEUTHOPHILUS DEVIUS (p. 99).

Described from a pair from one region.

Single type here designated: unique ♂; Explorations of Upper Missouri and Yellowstone under Lt. Warren, Montana; F. V. Hayden; Scudder Collection.

CEUTHOPHILUS NEOMEXICANUS (p. 100).

Based on four males and one female from a single locality.

Single type here designated: ♂; Fort Wingate, New Mexico; Shufeldt; U. S. N. M. Collection.

PHRIXOCNEMIS TRUCULENTUS (p. 103).

Based on two males and one female from two localities.

Single type here designated: ♂; Peru, Nebraska; Professor Taylor (*nec* Townsend); Hebard Collection, ex Bruner.

PHRIXOCNEMIS VALIDUS (p. 105).

Based on a unique male; California; H. Edwards; Scudder Collection.

PHRIXOCNEMIS BELLICOSUS (p. 106).

Based on a pair from Colorado.

Single type here designated: unique ♂; (probably Ute Pass,) Colorado, elevation 7,000 feet; H. K. Morrison; Scudder Collection.

III. "REVISION OF THE ORTHOPTERAN GROUP MELANOPLI (ACRIDIIDÆ), WITH SPECIAL REFERENCE TO NORTH AMERICAN FORMS," by Samuel Hubbard Scudder. (Proc. U. S. Nat. Mus., Vol. 20, pp. 1–421, Plates I–XXVI, 1897.)

The greater portion of the material studied in the paper before us was the property of Mr. Scudder; but a great number of specimens, many of species which were not contained in his collection were loaned to him for study by Professor Bruner and still others were sent to him for examination by the United States National Museum. Others furnished material for this revision, but in such small quantities that the paper may be said to be based almost wholly upon the material in the three mentioned collections. A very fair idea of the relative importance of these collections in the present work may be had from the number of lectotypes chosen from each of the collections in the present paper. Of these types there are fifty-seven in the Collection of the Museum of Comparative Zoology (all but three being from the Scudder Collection), thirty-eight in the Hebard Collection, ex Bruner, nineteen in the United States National Museum, one in the McNeill Collection, one in the University of Kansas Collection, and one in the Brunner von Wattenwyl Collection.

The choice of the types in the paper under consideration has been greatly facilitated by the fact that in almost every case one of the best and most suitable specimens in the typical series is figured, the

locality at which the specimen figured was taken is given in the explanation of the plate, and each specimen so utilized bears the label "drawn" in Mr. Scudder's handwriting. It is practically certain that these are the specimens which Mr. Scudder would have chosen as the single types of his new species had such action at that time been customary.

Practically every specimen of the group used in the preparation of this work was labelled "Scudder's Type," consequently such a label signifies solely that the specimen, if belonging to a species there described as new, belonged to the typical series.

In Mr. Scudder's paper the collection to which the material belongs is given in parentheses after each reference, but where no parentheses are to be found it is understood that the material belonged to Mr. Scudder himself.

All but three of the specimens chosen as lectotypes in the present paper have been examined by the authors.

GYMNOSCIRTETES PUSILLUS (p. 15).

Based on one pair from the same locality.

Single type here designated: unique figured ♂; Jacksonville, Duval County, Florida, [August, 1886]; Ashmead; Hebard Collection, ex Bruner.

NETROSOMA FUSIFORMIS (p. 17).

Based on three male and fourteen female specimens from one locality.

Single type here designated: figured ♂; Montelovez, Coahuila [Chihuahua in error], Mexico, September 20; E. Palmer; Scudder Collection.

NETROSOMA NIGROPLEURA (p. 18).

Based on two males from a single locality.

Single type here designated:. figured ♂; Lerdo, Durango, Mexico; L. Bruner; Hebard Collection, ex Bruner.

PHÆDROTETTIX ANGUSTIPENNIS (p. 22).

Based on six specimens of each sex from three localities.

Single type here designated: figured ♂; Mount Alvarez, San Luis Potosi, Mexico; E. Palmer; U. S. N. M. Collection.

CONALCÆA MIGUELITANA (p. 24).

Based on two male and three female specimens from one locality.

Single type here designated: figured ♂; Sierra de San Miguelito, San Luis Potosi, Mexico; E. Palmer; Scudder Collection.

CONALCÆA TRUNCATIPENNIS (p. 25).

Based on a single female specimen; Saltillo, Nuevo Leon, Mexico, March 21–28; E. Palmer; Scudder Collection.

CONALCÆA NEOMEXICANA (p. 26).

Based on a unique male: figured; Silver City, Grant County, New Mexico; Hebard Collection, ex Bruner.

BARYTETTIX CRASSUS (p. 28).

Based on one male specimen: figured; San Jose del Cabo, Lower California; G. Eisen; Hebard Collection, ex Bruner.

BARYTETTIX PENINSULÆ (p. 28).

Based on a unique female; Lower California; G. Eisen; Hebard Collection, ex Bruner.

PHAULOTETTIX COMPRESSUS (p. 30).

Based on a single male: figured; Montelovez, Coahuila, Mexico, September 20; E. Palmer; Scudder Collection.

CEPHALOTETTIX PARVULUS (p. 31).

Based on two males from different localities.

Single type here designated: figured ♂; Otoyac, Vera Cruz, Mexico, Elevation 2,700 feet, December; L. Bruner; Hebard Collection, ex Bruner.

RHABDOTETTIX CONCINNUS (p. 33).

Based on one male and two females from two localities.

Single type here designated: unique figured ♂; Waco, McLennan County, Texas, October 4, Mus. Comp. Zool. Collection.

RHABDOTETTIX PALMERI (p. 34).

Based on eight male and twelve female specimens from a single locality.

Single type here designated: figured ♂; Montelovez, Coahuila, Mexico, September 22; E. Palmer; Scudder Collection.

CYCLOCERCUS BISTRIGATA (p. 37).

Based on one male and four females from three localities.

Single type here designated: unique figured ♂; Venis Mecas, San Luis Potosi, Mexico, June 6; E. Palmer; Scudder Collection.

CYCLOCERCUS ACCOLA (p. 38).

Based on two males and a single female from two localities.

Single type here designated: figured ♂; Corpus Christi Bay,

Nueces County, Texas, December 11–20; E. Palmer; Scudder Collection.

CYCLOCERCUS VALGA (p. 39).

Based on a unique male: figured; Sierra Nola, Tamaulipas, Mexico, December 3–6; E. Palmer; Scudder Collection.

SINALOA BEHRENSII (p. 40).

Based on a pair from one locality.

Single type here designated: unique figured ♂; Sinaloa, Mexico; Koels; from Behrens; Scudder Collection.

PARAIDEMONA MIMICA (p. 43).

Based on four males and five females from four localities.

Single type here designated: figured ♂; Uvalde, Texas, last week of July; E. Palmer; Scudder Collection.

CAMPYLACANTHA SIMILIS (p. 52).

Based on a pair from a single locality.

Single type here designated: unique figured ♂; Lerdo, Durango, Mexico, November; L. Bruner; Hebard Collection, ex Bruner.

EOTETTIX SIGNATUS (p. 54).

Based on a single male: figured; East Florida; W. H. Ashmead; McNeill Collection.

HESPEROTETTIX MERIDIONALIS (p. 59).

Based on one male and two female specimens from two localities.

Single type here designated: unique figured ♂; Guanajuato, Mexico; A. Dugès; U. S. N. M. Collection.

HESPEROTETTIX FESTIVUS (p. 60).

Based on sixty-six males and fifty-eight females from five localities.

Single type here designated: figured ♂; Salt Lake Valley, Utah, Elevation 4,300 feet, August 1–4, [1877]; Scudder; Scudder Collection.

HESPEROTETTIX PACIFICUS (p. 61).

Based on two male and eight female specimens from two localities.

Single type here designated: figured ♂; Los Angeles [County], California; Koebele; Hebard Collection, ex Bruner.

HESPEROTETTIX CURTIPENNIS (p. 62).

Based on two females from one locality.

Single type here designated: ♀; Colorado, [1884]; Morrison; Hebard Collection, ex Bruner.

HESPEROTETTIX PRATENSIS (p. 64).

Based on forty males and sixty-eight females from thirty localities.

Single type here designated: figured ♂; Dallas, Texas, July 18; Boll; Scudder Collection.

ÆOLOPLUS TENUIPENNIS (p. 70).

Based on a single male: figured; Fort Grant, Graham County, Arizona; U. S. N. M. Collection.

ÆOLOPLUS ELEGANS (p. 71).

Based on one male: figured; Las Cruces, Donna Ana County, New Mexico, August 8, [1893]; T. D. A. Cockerell; U. S. N. M. Collection.

ÆOLOPLUS REGALIS Sc. (p. 71).

Nec *Caloptenus regalis* Dodge or *Melanoplus regalis* Bruner.

New name, *Æoloplus bruneri* Caudell (Proc. Ent. Soc. Wash., Vol. VIII, p. 134, 1906).

Based on five males and forty-one females from seven localities.

Single type here designated: figured ♂; Lakin, Kearny County, Kansas, elevation 3,000 feet, July–September; Scudder Collection.

ÆOLOPLUS CALIFORNICUS (p. 73).

Based on one male and four female specimens from California.

Single type here designated: unique figured ♂; California; Burrison; from Henshaw; Scudder Collection.

ÆOLOPLUS UNIFORMIS (p. 77).

Based on a pair from two localities.

Single type here designated: unique figured ♂; Fort Whipple, Yavapai County, Arizona; E. Palmer; Scudder Collection.

ÆOLOPLUS ARIZONENSIS (p. 78).

Based on five males and four females from one locality.

Single type here designated: figured ♂; Fort Whipple, Yavapai County, Arizona; Scudder Collection.

ÆOLOPLUS OCULATUS (p. 79).

Based on one male: figured; Mohave, Arizona; Wickham; Hebard Collection, ex Bruner.

BRADYNOTES CAURUS (p. 83).

Based on two male and six female specimens from three localities.

Single type here designated: figured ♂; Yakima River opposite Ellensburg, Kittitas County, Washington, July 8–9; U. S. N. M. Collection.

Bradynotes expleta (p. 84).

Based on two males and one female from a single locality.

Single type here designated: figured ♂; Easton, Kittitas County, Washington; Scudder Collection.

Bradynotes pinguis (p. 85).

Based on five males and two females from two localities.

Single type here designated[11]: ♂; Reno, Washoe County, Nevada, [June 23, 1890]; Hillman; Hebard Collection, ex Bruner.

Bradynotes referta (p. 88).

Based on two males and three female specimens from two localities.

Single type here designated: figured ♂; Soldier, Logan County, Idaho; Hebard Collection, ex Bruner.

Bradynotes satur (p. 89).

Based on a pair from one locality.

Single type here designated: unique figured ♂; Placer County, California, September; [Koebele]; U. S. N. M. Collection.

Podisma variegata (p. 101).

Based on two males and one female from two localities.

Single type here designated: figured ♂; Ithaca, Tomkins County, New York, elevation about 400 feet, November; J. H. Comstock; Scudder Collection.

Podisma nubicola (p. 102).

Based on ten male and seven female specimens from a single locality.

Single type here designated: figured ♂; Mount Lincoln, Park County, Colorado, above timber, elevation 11,000–13,000 feet, August 13, [1877]; S. H. Scudder; Scudder Collection.

Podisma ascensor (p. 107).

Based on a pair from one locality.

Single type here designated: unique figured ♂; American Fork Canyon, Utah; A. S. Packard; Scudder Collection.

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[11] As the original locality of the figured specimen is in doubt, we use in this case the first exact record of locality given.

PODISMA PARNASSICA (p. 113).

Based on a pair from the same locality.

Single type here designated: unique figured ♂; Mt. Parnassus, Greece; Brunner von Wattenwyl Collection.

PODISMA DAIRISAMA (p. 114).

Based on a pair from Japan.

Single type here designated: unique figured ♂; Japan; U. S. N. M. Collection. Material can not be found.

PARATYLOTROPIDIA BRUNNERI (p. 118).

Based on a pair from different localities.

Single type here designated: unique figured ♂; Dakota; Hebard Collection, ex Bruner.

MELANOPLUS MARCULENTUS (p. 139).

Based on thirty-two male and forty-two female specimens from eight localities.

Single type here designated: figured ♂; Sierra de San Miguelito, San Luis Potosi, Mexico; E. Palmer; Scudder Collection.

MELANOPLUS SONORÆ (p. 143).

Based on one male and four females from one locality.

Single type here designated: unique figured ♂; Sonora, Mexico; A. Schott; Mexican Boundary Survey; U. S. N. M. Collection. Material cannot be found.

MELANOPLUS CUNEATUS (p. 147).

Based on three males from three localities.

Single type here designated: figured ♂; Silver City, Grant County, New Mexico; U. S. N. M. Collection.

MELANOPLUS SIMPLEX (p. 150).

Based on two males and one female from Colorado.

Single type here designated; figured ♂; Colorado, elevation 5,500 feet; Morrison; Scudder Collection.

MELANOPLUS RILEYANUS (p. 151).

Based on six males and seventeen females from four localities.

Single type here designated: figured ♂; Los Angeles County, California, (May, September); Coquillett; U. S. N. M. Collection.

MELANOPLUS FLAVESCENS (p. 155).

Based on a single male: figured; San Diego [County], California; Coquillett; U. S. N. M. Collection.

MELANOPLUS PICTUS (p. 156).

Based on a unique male: figured; Bradshaw Mountain, Arizona, June 21, [1892]; Hebard Collection, ex Bruner.

MELANOPLUS ELONGATUS (p. 160).

Based on five male and four female specimens from five localities.

Single type here designated: figured ♂; Bledos, San Luis Potosi, Mexico, October; E. Palmer; Scudder Collection.

MELANOPLUS BRUNERI (p. 164).

Based on twenty-three males and twenty-five females from twelve localities.

Single type here designated: figured ♂; Fort McLeod, Alberta, Canada, August [1882]; Hebard Collection, ex Bruner.

MELANOPLUS EXCELSUS (p. 166).

Based on four male and five female specimens from a single locality.

Single type here designated: figured ♂; Mt. Lincoln, Park County, Colorado, above timber, elevation 11,000–13,000 feet, August 13, [1877]; Scudder Collection.

MELANOPLUS UTAHENSIS (p. 167).

Based on a unique male; figured; Salt Lake [Valley], Utah, August 30; L. Bruner; U. S. N. M. Collection.

MELANOPLUS ALASKANUS (p. 169).

Based on two males and one female from two localities.

Single type here designated: figured ♂; Alaska; T. C. Mendenhall; U. S. N. M. Collection.

MELANOPLUS AFFINIS (p. 171).

Based on six males and four females from eight localities.

Single type here designated: figured ♂; Salt Lake Valley, Utah, August 30; L. Bruner; Hebard Collection, ex Bruner.

MELANOPLUS INTERMEDIUS (p. 172).

Based on fifteen male and twenty-three female specimens from five localities.

Single type here designated: second[12] figured ♂; Yellowstone, Montana, August, [1888]; Hebard Collection, ex Bruner.

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[12] This specimen was chosen as type rather than the first figured, owing to the fact that the specimen is in the best condition.

MELANOPLUS DEFECTUS (p. 177).

Based on a pair from the same locality.

Single type here designated: unique figured ♂; Grand Junction, Mesa County, Colorado, June, [1893]; L. Bruner; Hebard Collection, ex Bruner.

MELANOPLUS DIMINUTUS (p. 190).

Based on five males and nine females from three localities.

Single type here designated: figured ♂; Monterey, California, October 19, next seashore; Scudder Collection.

MELANOPLUS CONSANGUINEUS (p. 192).

Based on a pair from a single locality.

Single type here designated: unique figured ♂; [Sonoma[13]] County, California, October; [Koebele]; U. S. N. M. Collection.

MELANOPLUS SIERRANUS (p. 193).

Based on twenty-eight male and twenty-three female specimens from three localities.

Single type here designated: figured ♂; Truckee, Nevada County, California, October 10; Scudder Collection.

MELANOPLUS ATER (p. 194).

Based on two males and three females from one locality.

Single type here designated: figured ♂; San Francisco, California, November, [1887]; Hebard Collection, ex Bruner.

MELANOPLUS VIRGATUS (p. 199).

Based on eleven males and twelve females from six localities.

Single type here designated[14]: ♂; Siskiyou County, California, July; Riley; Scudder Collection.

MELANOPLUS UNIFORMIS (p. 201).

Described from nine male and eight female specimens from five localities.

Single type here designated: figured ♂; Sacramento County, California; Coquillett; U. S. N. M. Collection.

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[13] Sacramento County instead of Sonoma County has been given by mistake in the original description, and for the same specimen, Sonora County in the plate reference.

[14] As the figured specimen of this species is probably lost, having been sent to McNeill, we have chosen a specimen from the first definite locality given as the single type.

Melanoplus angelicus (p. 202).

Described from two male specimens from the same locality.

Single type here designated: figured ♂; Los Angeles, California; Coquillett; U. S. N. M. Collection.

Melanoplus impudicus (p. 204).

Based on one male and two female specimens from two localities.

Single type here designated: unique figured ♂; Georgia; Morrison; Scudder Collection.

Melanoplus nitidus (p. 207).

Based on a pair from two localities.

Single type here designated: unique figured ♂; Tepic, Jalisco, Mexico, November; Hebard Collection, ex Bruner.

Melanoplus indigens (p. 211).

Described from a single male: figured; Salmon City, Lemhi County, Idaho, August, [1883]; Hebard Collection, ex Bruner.

Melanoplus gillettei (p. 215).

Based on two males from the same locality.

Single type here designated: figured ♂; Rabbit Ears Pass, Colorado, elevation about 10,000 feet, July 20; C. P. Gillette; Scudder Collection.

Melanoplus artemisiæ (p. 217).

Based on four male and ten female specimens from a single locality.

Single type here designated: figured ♂; Salmon City, Lemhi County, Idaho, August, [1888]; Scudder Collection.

Melanoplus cancri (p. 219).

Based on a pair from the same locality.

Single type here designated: unique figured ♂; Cape St. Lucas, Lower California; J. Xantus; Hebard Collection, ex Bruner.

Melanoplus reflexus (p. 221).

Described from a pair from one locality.

Single type here designated: unique figured ♂; Ciudad del Maiz, San Luis Potosi, Mexico; E. Palmer; Scudder Collection.

Melanoplus meridionalis (p. 223).

Based on three males and eight females from a single locality.

Single type here designated: figured ♂; Mount Alvarez, San Luis Potosi, Mexico; E. Palmer; Scudder Collection.

Melanoplus militaris (p. 224).

Based on a pair from the same locality.

Single type here designated: unique figured ♂; Soldier, Logan County, Idaho; Hebard Collection, ex Bruner.

Melanoplus gladstoni (p. 229).

Based on eighteen males and nine females from five localities.

Single type here designated: figured ♂; Medicine Hat, Assiniboia, September, [1882]; Hebard Collection, ex Bruner.

Melanoplus palmeri (p. 230).

Based on four specimens of each sex from two localities.

Single type here designated: figured ♂; Fort Whipple, Yavapai County, Arizona; E. Palmer; Scudder Collection.

Melanoplus walshii (p. 235).

Based on one male and seven female specimens from three localities.

Single type here designated:[15] ♀; Rock Island, Illinois; B. D. Walsh; Scudder Collection.

Melanoplus gracilipes (p. 238).

Based on three males and one female from one locality.

Single type here designated: figured ♂; Los Angeles, California; Coquillett; Hebard Collection, ex Bruner.

Melanoplus geniculatus (p. 239).

Described from a pair from Mexico.

Single type here designated: unique figured ♂; Mexico; from W. S. Blatchley; Scudder Collection.

Melanoplus tenuipennis (p. 244).

Based on three males and five females from five localities.

Single type here designated: figured ♂; Los Angeles, California; Coquillett; Hebard Collection, ex Bruner.

Melanoplus missionum (p. 246).

Based on two males and one female from a single locality.

Single type here designated: figured ♂; Los Angeles [County], California, [July]; Coquillett; Scudder Collection.

Melanoplus fuscipes (p. 247).

Based on six male and four female specimens from five localities.

[15] The unfigured female from Walsh is chosen as single type in accord with Scudder's notes. We have, however, examined the eight specimens and find them to be the same species.

Single type here designated: figured ♂; between San Luis Obispo and San Simeon Bay, California; E. Palmer; Scudder Collection.

MELANOPLUS SCITULUS (p. 249).

Based on two males and one female from one locality.

Single type here designated: figured ♂; Mount Alvarez, San Luis Potosi, Mexico; E. Palmer; Scudder Collection.

MELANOPLUS INORNATUS (p. 254).

Based on one male and two females from probably two localities.

Single type here designated:[16] ♀; Montelovez, Coahuila, Mexico, (September 20); E. Palmer; Scudder Collection.

MELANOPLUS VIRIDIPES (p. 255).

Based on twelve males and thirteen females from six localities.

Single type here designated: figured ♂; Moline, Rock Island County, Illinois; [June 5, 1888]; McNeill; Scudder Collection.

MELANOPLUS DECORUS (p. 257).

Based on two males from the same locality.

Single type here designated: figured ♂; Pungo Bluff (Dingo Bluff *sic*), North Carolina, November 15, [1876]; Parker [and] Maynard; Scudder Collection.

MELANOPLUS ATTENUATUS (p. 259).

Based on three male specimens from a single locality.

Single type here designated: figured ♂; Smithville, Brunswick County, North Carolina, November 22, [1876]; [Parker and] Maynard; Scudder Collection.

MELANOPLUS AMPLECTENS (p. 260).

Based on a single male: figured; Bee Spring, Edmonson County, Kentucky, June 14–15; F. G. Sanborn; Mus. Comp. Zool. Collection.

MELANOPLUS SALTATOR (p. 261).

Based on ten male and fourteen female specimens from four localities.

Single type here designated: figured ♂; Portland, Multnomah County, Oregon; Packard; Scudder Collection.

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[16] In this instance the unique figured male was sent to McNeill; the specimen had no data.

MELANOPLUS JUVENCUS (p. 266).

Described from a single male: figured; no data on specimen marked figured, in original description "Fort Reed, Orange County, Florida, April 8; Comstock" is given. Scudder Collection.

MELANOPLUS ALLENI (p. 273).

Based on two male specimens from two localities.

Single type here designated: figured ♂; Crawford County, Iowa; July 13–24; J. A. Allen; Scudder Collection.

MELANOPLUS SNOWII (p. 274).

Based on a pair from a single locality.

Single type here designated: unique figured ♂; Magdalena, Socorro County, New Mexico, July; F. H. Snow; University of Kansas Collection.

MELANOPLUS PROPINQUUS (p. 285).

Based on seventy-seven males and eighty-seven females from thirteen localities.

Single type here designated: figured ♂; Fort Reed, Orange County, Florida, April 23, [1876]; J. H. Comstock; Scudder Collection.

MELANOPLUS MONTICOLA (p. 290).

Based on two pairs from a single locality.

Single type here designated: figured ♂; Sierra Blanca, Colorado, above timber, elevation 12,000–13,000 feet, August 29, 1877; S. H. Scudder; Scudder Collection.

MELANOPLUS BISPINOSUS (p. 292).

Based on three males and two females from three localities.

Single type here designated:[17] ♂; Tiger Mills, Burnet County, Texas; L. Bruner; Hebard Collection, ex Bruner.

MELANOPLUS TERMINALIS (p. 293).

Based on five males from two localities.

Single type here designated: figured ♂; Gulf Coast of Texas; Aaron; Scudder Collection.

MELANOPLUS CYANIPES (p. 295).

Based on fifteen male and nine female specimens from four localities.

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[17] A male from the first definite locality is chosen because the figured specimen from the Bruner Collection has been destroyed.

Single type here designated: figured ♂; Pasadena, Los Angeles County, California, October 23; Scudder Collection.

MELANOPLUS COMPLANATIPES (p. 298).

Based on two males and three females from two localities.

Single type here designated: figured ♂; Cape St. Lucas, Lower California; J. Xantus; Scudder Collection.

MELANOPLUS CANONICUS (p. 300).

Based on a pair from the same locality.

Single type here designated: unique figured ♂; Grand Canyon of the Colorado, Arizona, July 10, [1892]; Hebard Collection, ex Bruner.

MELANOPLUS COMPTUS (p. 302).

Based on two males from different localities.

Single type here designated: figured ♂; Sidney, Cheyenne County, Nebraska, August 25; Hebard Collection, ex Bruner.

MELANOPLUS COCCINEIPES (p. 303).

Based on twenty-eight males and thirty-one females from seventeen localities.

Single type here designated: figured ♂; Sand Hills, Nebraska, July; L. Bruner; Hebard Collection, ex Bruner.

MELANOPLUS IMPIGER (p. 306).

Based on sixteen males and thirty-six females from nine localities.

Single type here designated: figured ♂; Barber County, Kansas; Cragin; Hebard Collection, ex Bruner.

MELANOPLUS CORPULENTUS (p. 313).

Based on nineteen male and fifteen female specimens from seven localities.

Single type here designated: figured ♂; Sierra de San Miguelito, San Luis Potosi, Mexico; E. Palmer; Scudder Collection.

MELANOPLUS CONSPERSUS (p. 315).

Based on a pair from the same locality.

Single type here designated: unique figured ♂; Southwest Nebraska; L. Bruner; Hebard Collection, ex Bruner.

MELANOPLUS COMPACTUS (p. 316).

Based on two pairs from two localities.

Single type here designated: figured ♂; Dakota; U. S. N. M. Collection.

MELANOPLUS VARIABILIS (p. 319).

Based on two pairs from two localities.

Single type here designated: figured ♂; City of Mexico, Mexico, November, [1887]; L. Bruner; Hebard Collection, ex Bruner.

MELANOPLUS LEPIDUS (p. 321).

Based on six males and seven females from three localities.

Single type here designated: figured ♂; Truckee, Nevada County, California, October 10; Scudder Collection.

MELANOPLUS INOPS (p. 329).

Described from a unique male: figured; Florida; Pridday; Hebard Collection, ex Bruner.

MELANOPLUS PAROXYOIDES (p. 331).

Based on three males and four females from two localities.

Single type here designated: figured ♂; Key West, Florida; Morrison; Scudder Collection.

MELANOPLUS ALPINUS (p. 333).

Described from thirteen males and eleven females from three localities.

Single type here designated: figured ♂; Henry Lake, Idaho, August; L. Bruner; U. S. N. M. Collection.

MELANOPLUS CONFUSUS (p. 339).

Based on one male and three females from two localities.

Single type here designated: unique figured ♂; Munsons Hill (Kentucky?), July 12; Mus. Comp. Zool. Collection.

MELANOPLUS FURCATUS (p. 358).

Based on one pair from one locality.

Single type here designated: unique figured ♂; Jacksonville, Duval County, Florida; Pridday; Hebard Collection, ex Bruner.

MELANOPLUS THOMASI (p. 368).

Based on a unique male: figured; Lerdo, Durango, Mexico, November; L. Bruner; Hebard Collection, ex Bruner.

MELANOPLUS OLIVACEUS (p. 370).

Described from three males and two females from one locality.

Single type here designated: figured ♂; Los Angeles, California, July, [1886]; Coquillett; Hebard Collection, ex Bruner.

MELANOPLUS ARBOREUS (p. 372).

Described from six males and two females from three localities.

Single type here designated: figured ♂; Dallas, Texas; Boll; Scudder Collection.

POECILOTETTIX SANGUINEUS (p. 387).

Based on a pair from a single locality.

Single type here designated: figured ♂; Bradshaw Mountain, Arizona, June 21; A. B. Cordley; Hebard Collection, ex Bruner.

POECILOTETTIX COCCINATUS (p. 389).

Based on one male and three females from the same locality.

Single type here designated: unique figured ♂; Los Angeles [County], California, [July]; Coquillett; U. S. N. M. Collection.

IV. "SUPPLEMENT TO A REVISION OF THE MELANOPLI," by Samuel Hubbard Scudder. (Proc. Davenport Academy of Nat. Sci., Davenport, Iowa. Vol. VII, pp. 157–205, plates VII–IX, 1899.)

In the paper here considered we find all but four of the species described, with the specimens which should be chosen as lectotypes, in the Scudder Collection; of the four remaining, the lectotypes of two should be chosen from the Morse Collection, one from the Hancock Collection, and one from the Collection of C. F. Baker; the last two alone have not been personally examined by the authors.

The method followed is the same as in the Revision of the Melanopli, where figures are given in the present paper; so that the choice of the lectotype is likewise more easy and satisfactory than usual.

Although the first sets of all the material collected on the Pacific Coast in 1897 by Professor Morse and described in this paper by Mr. Scudder were to go to the author, the large series of many species remaining are all the property of Professor Morse.

PODISMA POLITA (p. 158).

Based on nineteen males and eight females from a single locality.

Single type here designated: figured ♂; Divide (*nec* Cottage Grove), Lane County, Oregon, September 12, [1897]; A. P. Morse; Scudder Collection.

MELANOPLUS BLANDUS (p. 161).

Based on seven males from one locality.

Single type here designated: figured ♂; summit of Mount

Wilson (*nec* Altadena), Los Angeles County, California, July 28, [1897]; A. P. Morse; Scudder Collection.

MELANOPLUS INCISUS (p. 163).

Described from a unique male; Fort Collins, Larimer County, Colorado, August 11; C. F. Baker; C. F. Baker Collection.

MELANOPLUS FEMUR-NIGRUM (p. 165).

Based on thirteen males and one female from one locality.

Single type here designated: figured ♂; San Francisco Mountains, near Flagstaff, Coconino County, Arizona, July 30, [1897]; Dr. J. L. Hancock; Scudder Collection.

MELANOPLUS VARICUS (p. 168).

Described from fourteen males and six females from a single locality.

Single type here designated: figured ♂; Tehachapi, Kern County, California, August 2, [1897]; A. P. Morse; Scudder Collection.

MELANOPLUS IMMUNIS (p. 170).

Described from two males and one female from one locality.

Single type here designated: ♂; Mary's Peak, Benton County, Oregon, September 16, [1897]; A. P. Morse; Scudder Collection.

MELANOPLUS ACUTUS (p. 171).

Described from two males and one female from one locality.

Single type here designated: ♂; Brown's Valley, Traverse County, Minnesota, October 26; O. Lugger; Scudder Collection.

MELANOPLUS USITATUS (p. 172).

Based on a pair from a single locality.

Single type here designated: unique ♂; Corvallis, Benton County, Oregon, June 9, [1895]; A. B. Cordley; Morse Collection.

MELANOPLUS PINCTUS (p. 175).

Based on seven pairs from three localities.

Single type here designated: figured ♂; San Diego, California, July 22, [1897]; A. P. Morse; Scudder Collection.

MELANOPLUS TRUNCATUS (p. 177).

Described from six males and one female from the same locality.

Single type here designated: figured ♂; San Francisco Mountains, ([near] Flagstaff), Coconino County, Arizona, July 31, [error pro 30], [1897]; Dr. J. L. Hancock; Scudder Collection.

Melanoplus phœtaliotiformis (p. 179).

Described from nineteen males and fourteen females from a single locality.

Single type here designated: figured ♂; Gazelle, Siskiyou County, California, September 5, [1897]; A. P. Morse; Scudder Collection.

Melanoplus incultus (p. 181).

Described from four males and two females from two localities.

Single type here designated: figured ♂; foothills five miles west of Fort Collins, Colorado, July 10; C. F. Baker; Scudder Collection.

Melanoplus franciscanus (p. 183).

Described from forty-eight males and twenty-one females from a single locality.

Single type here designated: figured ♂; San Francisco Mountains ([near] Flagstaff), Coconino County, Arizona, July 30, [1897]; Dr. J. L. Hancock; Hancock Collection.

Melanoplus ablutus (p. 185).

Based on two males and nine females from one locality.

Single type here designated: figured ♂; Wawona, Mariposa County, California, August 13, [1897]; A. P. Morse; Scudder Collection.

Melanoplus nanus (p. 187).

Based on twenty-seven males and twenty-two females from four localities.

Single type here designated: figured ♂; Berkeley, Alameda County, California, August 21, [error pro 20], [1897]; A. P. Morse; Scudder Collection.

Melanoplus ligneolus (p. 188).

Based on eight pairs from two localities.

Single type here designated: figured ♂; Benicia, Solano County, California, August 26, [1897]; A. P. Morse; Scudder Collection.

Melanoplus dealbatus (p. 190).

Based on five males and thirteen females from a single locality.

Single type here designated: figured ♂; Ceres, Stanislaus County, California, August 17, [1897]; A. P. Morse; Scudder Collection.

Melanoplus pilatus (p. 192).

Based on one pair from two localities.

Single type here designated: unique ♂[18]; mouth of Big South River, Larimer County, Colorado, elevation 8,000 feet, August 3; C. F. Baker; Scudder Collection.

MELANOPLUS ASCENSUS (p. 196).

Based on five males from two localities.

Single type here designated: figured ♂; Mount Shasta, Northern California, just below the forest line, September 2, [1897]; A. P. Morse; Scudder Collection.

MELANOPLUS VALIDUS (p. 197).

Based on forty-three males and females from three localities.

Single type here designated: figured ♂; Grant's Pass, Josephine County, Oregon, September 8, [1897]; A. P. Morse; Scudder Collection.

MELANOPLUS ALGIDUS (p. 199).

Based on thirty-six pairs from the same locality.

Single type here designated: figured ♂; Mary's Peak, Benton County, Oregon, September 16, [1897]; A. P. Morse; Scudder Collection.

MELANOPLUS DEBILIS (p. 201).

Described from twenty males and twenty-six females from two localities.

Single type here designated: figured ♂; Ashland, Jackson County, Oregon, September 7, [1897]; A. P. Morse; Scudder Collection.

MELANOPLUS CALIDUS (p. 203).

Described from a pair from the same locality.

Single type here designated: unique ♂; Gilman's Ranch, Eagle Creek, White Mountains, Lincoln County, New Mexico, elevation 7,000 feet, August 10–16, [1897]; E. O. Wooton; Morse Collection.

V. "SHORT STUDIES OF NORTH AMERICAN TRYXALINÆ," by Samuel Hubbard Scudder. (Proc. American Academy of Arts and Sciences, Vol. XXXV, pp. 41–57, 1899.)

The lectotypes here chosen of all the new species described in the paper before us are in the Scudder Collection and have been examined by the authors.

[18] The female of this species has been figured, but the importance of the other sex in this genus makes it advisable to choose the unique unfigured male as the lectotype.

As is the case with other material collected by Professor Morse in 1897 and described by Mr. Scudder, the first sets of specimens of new species taken by Professor Morse are in the Scudder Collection while the remaining large series are in the Morse Collection.

MERMIRIA INTERTEXTA (p. 42).

Described from two pairs from two localities.

Single type here designated: ♂; Georgia; Morrison; Scudder Collection.

MERMIRIA VIGILANS (p. 43).

Described from two males and four females from a single locality.

Single type here designated: ♂; Smithville, North Carolina, November 22, [1876]; [Parker and Maynard]; Scudder Collection.

ACENTETUS CARINATUS (p. 45).

Based on a unique male; Florissant, Colorado, August 17–22, [1877]; (S. H. Scudder); Scudder Collection.

OPEIA TESTACEA (p. 46).

Described from twenty-five males and seventeen females from four localities.

Single type here designated: ♂; Lancaster, California, August 1, 1897; A. P. Morse; Scudder Collection.

ŒONOMUS ALTUS (p. 47).

Based on fifteen males and nine females from a single locality.

Single type here designated: ♂; Mount Wilson, [*nec* Altadena], California, elevation 2,400 feet, July 27, [1897]; A. P. Morse; Scudder Collection.

HORESIDOTES CINEREUS (p. 49).

Described from nineteen male and eleven female specimens from two localities.

Single type here designated: ♂; (Palm Cañon), Palm Springs, California, July 13, [1897]; A. P. Morse; Scudder Collection.

STENOBOTHRUS OREGONENSIS (p. 50).

Described from numerous specimens from thirteen localities.

Single type here designated: ♂; Divide, Oregon,[19] September 12, [1897]; A. P. Morse; Scudder Collection.

[19] A specimen from this locality was chosen as the single type owing to the fact that Divide, Oregon, is about the middle of the northward and southward range of this species.

STIRAPLEURA PUSILLA (p. 52).

Based on eighty-nine males and eighty females from seventeen localities.

Single type here designated: ♂; Mesilla, New Mexico, July 1, [1897]; A. P. Morse; Scudder Collection.

STIRAPLEURA TENUICARINA (p. 53).

Described from a unique female; Sierra Blanca, El Paso County, Texas, June 26, [1897]; A. P. Morse; Scudder Collection.

AULOCARA RUFUM (p. 55).

Based on five males and four females from one locality.

Single type here designated: ♂; Pueblo, Colorado, August 30–31, [1877], [elevation 4,700 feet]; Scudder Collection.

AULOCARA FEMORATUM (p. 55).

Described from five males from four localities.

Single type here designated: ♂; Lakin, Kansas, September 1, [1877], [elevation 3,000 feet]; Scudder Collection.

AULOCARA PARALLELUM (p. 57).

Described from a pair from the same locality.

Single type here designated: unique ♂; Salt Lake Valley, Utah, August 1–4; Scudder Collection.

VI. "THE ORTHOPTERAN GENUS SCHISTOCERCA," by Samuel Hubbard Scudder. (Proc. American Academy of Arts and Sciences, Vol. XXXIV, pp. 441–476, 1899.)

There are twenty-three species described as new in the paper before us; of these we have found it advisable to choose the lectotypic specimens of nineteen of the new species from the Scudder Collection and the remaining four from the Hebard Collection, ex Bruner. The majority of specimens upon which these descriptions are based are dried alcoholics and many are, moreover, in very poor condition. In a few cases these factors have been consequently of more importance than usual in selecting a specimen from the type series as single type. There are no figures whatever. The labelling is the same as in "The North American Ceuthophili," the second paper treated in the present series, the date 1899, of course, being used. The exact location of the material is given as chiefly from the Scudder Collection.

SCHISTOCERCA GRACILIS (p. 447).

Described from a unique male; South America; Scudder Collection.

SCHISTOCERCA AURANTIA (p. 448).

Based on one male and eight females from four localities.

Single type here designated: ♀ [20]; Meridá [*nec* Meriden], Yucatan; Scudder Collection.

SCHISTOCERCA CARINATA (p. 449).

Based on a series of one male and six females from four localities.

Single type here designated: ♀ [21]; Vera Cruz, Mexico; Heyde; Hebard Collection, ex Bruner.

SCHISTOCERCA CROCOTARIA (p. 450).

Described from a series of five females from two localities.

Single type here designated: ♀; Chontales, Nicaragua; Scudder Collection.

SCHISTOCERCA INTERRITA (p. 450).

Based on two females from Peru.

Single type here designated: ♀; Peru; H. Edwards; Scudder Collection.

SCHISTOCERCA CAMERATA (p. 451).

Described from a series of three females from one locality.

Single type here designated: ♀; Sinaloa, Mexico; Koels; Scudder Collection.

SCHISTOCERCA MELLEA (p. 452).

Described from a pair from one locality.

Single type here designated: unique ♂; Vera Cruz, Mexico; Heyde; Hebard Collection, ex Bruner.

SCHISTOCERCA ZAPOTECA (p. 453).

Based on twenty-one males and thirteen females from five localities.

Single type here designated: ♂; Venis Mecas, Mexico, January 6; Palmer; Scudder Collection.

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[20] This specimen is chosen as single type as it comes from the first definite locality and is in much better condition than the other specimens of the typical series.

[21] This specimen is chosen as the single type as it fits the description perfectly, is in good condition and comes from a definite locality; it is the only specimen of the typical series which is satisfactory in all of these respects.

SCHISTOCERCA PYRAMIDATA (p. 454).

Described from two males and five females from one locality.

Single type here designated: ♂; Cuernavaca, Mexico; Barrett; Scudder Collection.

SCHISTOCERCA DESILIENS (p. 455).

Described from one male and four females from two localities.

Single type here designated: unique ♂; Rio de Janeiro, Brazil, November; Scudder Collection, (from Mus. Comp. Zool.).

SCHISTOCERCA INFUMATA (p. 457).

Described from seven male and three female specimens from two localities.

Single type here designated: ♂; Montevideo, Uruguay; Meyer-Dür; Scudder Collection.

SCHISTOCERCA ÆQUALIS (p. 458).

Based on two males from the same locality.

Single type here designated: ♂; Demerara, British Guiana; Scudder Collection.

SCHISTOCERCA MAYA (p. 458).

Based on three males from two localities.

Single type here designated: ♂; Venis Mecas, Mexico, January 6; Palmer; Scudder Collection.

SCHISTOCERCA GULOSA (p. 459).

Based on a single female; Demerara, British Guiana; Scudder Collection.

SCHISTOCERCA BOGOTENSIS (p. 460).

Described from two females from a single locality.

Single type here designated: ♀; Bogotá, Columbia; Scudder Collection.

SCHISTOCERCA IDONEA (p. 461).

Based on three females from the same locality.

Single type here designated: ♀; Chapada [*nec* Crapada], Brazil, July–August; Scudder Collection, (from Mus. Comp. Zool.).

SCHISTOCERCA SONORENSIS (p. 463).

Based on two males from a single locality.

Single type here designated: ♂; Sonora, Mexico; Schott; Scudder Collection.

SCHISTOCERCA LINEATA (p. 465).

Based on two males and ten females from five localities.

Single type here designated: ♂; Barber County, Kansas; Cragin; Hebard Collection, ex Bruner.

SCHISTOCERCA VENUSTA (p. 467).

Described from twenty-two males and sixteen females from twelve localities.

Single type here designated: ♂[22]; Indio, California, July 9, 1897; Morse; Scudder Collection.

SCHISTOCERCA MEXICANA (p. 468).

Described from a single male: Sinaloa, Mexico; Koels; Scudder Collection.

SCHISTOCERCA SEPARATA (p. 469).

Described from one male and two females from two localities.

Single type here designated: unique ♂; Chontales, Nicaragua; Scudder Collection.

SCHISTOCERCA OBLIQUATA (p. 470).

Based on one male and two females from a single locality.

Single type here designated: unique ♂; San José del Cabo, Lower California, Mexico; Hebard Collection, ex Bruner.

SCHISTOCERCA PERTURBANS (p. 471).

Based on five female specimens from three localities.

Single type here designated: ♀; Paramaribo, Dutch Guiana; Richardson; Scudder Collection, (from Mus. Comp. Zool.).

VII. "THE SPECIES OF THE ORTHOPTERAN GENUS DEROTMEMA," by Samuel Hubbard Scudder. (Proc. American Academy of Arts and Sciences, Vol. XXXV, pp. 387–395, 1900.)

In the short paper before us we find all of the species described, with the specimens which should be chosen as lectotypes, in the Scudder Collection, and all of the specimens so chosen in the present paper have been examined by the authors.

The first sets of all the material collected on the Pacific Coast in 1897 by Professor Morse and described in this paper by Mr. Scudder were to go to the author, the great majority of remaining specimens were to go to Professor Morse.

[22] This specimen is chosen as the single type as it is in the best of condition and is in accord with the description throughout.

DEROTMEMA LATICINCTUM (p. 389).

Based on thirty males and twenty-eight females from five localities.

Single type here designated:[23] ♂; Mesilla, New Mexico, June 30, [1897]; A. P. Morse; Scudder Collection.

DEROTMEMA DELICATULUM (p. 390).

Based on five males and three females from three localities.

Single type here designated: ♂; Lancaster, California, July 31, [1897]; A. P. Morse; Scudder Collection.

DEROTMEMA SAUSSUREANUM (p. 391).

Based on forty-five males and thirty-four females from eight localities.

Single type here designated: ♂; San Bernardino, California, July 16, [1897]; A. P. Morse; the type specimen has blue wings. Scudder Collection.

DEROTMEMA LENTIGINOSUM (p. 393).

Based on ten males and two females from two localities.

Single type here designated: ♂; South Park, Colorado, August 11–16, [1877], [Altitude 8,000–10,000 feet]; (S. H. Scudder); Scudder Collection.

DEROTMEMA LICHENOSUM (p. 394).

Based on forty males and fourteen females from ten localities.

Single type here designated: ♂; Alkali [Stage Station, Green River], Wyoming, July 27, [1877], [elevation 6,000 feet]; (S. H. Scudder); Scudder Collection.

SECTION TWO.

In this section of the series of Single Type papers it has been decided to treat the North American species which have been described by the authors. It has seemed best to consider these all in one paper, not making divisions of the different papers in which the new species were described, owing to the frequent brevity and considerable number of such papers. In the present paper we have few of the difficulties to contend with which we encountered and discussed in Section One of this series of articles, because it has always been the custom of the authors to describe new species from one specimen, if but one sex of a new species was at hand, and from two

[23] There is no male specimen in the typical series from Las Cruces, New Mexico, the first locality given in the original description.

specimens, one of each sex, if both sexes were available. It is consequently evident that, among the species at present under consideration, a great number will be found already limited to a single type, and the present limitations of the others consist merely in determining which sex should be selected as single type. There is but one case, that of *Homœogamia subdiaphana mohavensis*, where, in the original description, the limitation was accidentally overlooked. The present paper falls naturally into two portions. The first of these treats those species which have been described by the senior author; there are forty-five of these, of which twenty-four are located in the Academy of Natural Sciences of Philadelphia, eleven in the Collection of the University of Kansas, six in the Hebard Collection and two each in the United States National Museum and the Museum of the Brooklyn Institute of Arts and Sciences. The second portion treats those species described jointly by the authors of the present paper; there are thirty-eight of these, thirty-four in the Hebard Collection, three in the Academy of Natural Sciences of Philadelphia and one in the United States National Museum. The nomenclature given will be that of the original description, as these papers are not intended to be at all revisionary; the names generally conceded to be absolute synonyms, however, have been omitted.

Part One—Species of North American Orthoptera described by James A. G. Rehn.

Ischnoptera johnsoni.

Ent. News, Vol. XIV, p. 234, 1903.

Based on a unique male from St. Augustine, Florida; C. W. Johnson; A. N. S. P. Collection.

Homœogamia erratica.

Proc. Acad. Nat. Sci. Phila., 1903, p. 187.

Described from one male from Prescott, Arizona, June 10, 1902; Oslar; A. N. S. P. Collection.

Chorisoneura plocea.

Ent. News, Vol. XV, p. 164, 1904.

Described from a unique female from the coast of South Carolina [probably near Charleston];[24] Hebard Collection.

[24] Brackets are used in the present paper wherever additional data is given to that contained in the original description.

LITANEUTRIA SKINNERI.

PROC. ACAD. NAT. SCI. PHILA., 1907, p. 26, fig. 1.

Based on a pair from the same locality.

Single type here designated: figured ♂ type; Carr Canyon, Huachuca Mountains, Cochise County, Arizona, August, 1905; Dr. H. Skinner; A. N. S. P. Collection.

STAGMOMANTIS GRACILIPES.

PROC. ACAD. NAT. SCI. PHILA., 1907, p. 67, figs. 15, 16.

Described from a unique figured male from the Baboquivari Mountains, Pima County, Arizona, August, 1906; F. H. Snow; University of Kansas Collection.

VATES TOWNSENDI.

Proc. U. S. Nat. Mus., Vol. XXVII, p. 573, 1904.

Described from a unique female taken at Zapotlan, Jalisco, Mexico, July 8, 1902; C. H. T. Townsend; A. N. S. P. Collection.

SERMYLE ARBUSCULA.

Can. Ent., Vol. XXXIV, p. 141, 1902.

Based on a unique female taken at San Diego, California, May 7, 1901; G. W. Dunn; A. N. S. P. Collection.

PROROCORYPHA SNOWI.

Kan. Univ. Sci. Bull., Vol. V, No. 17, p. 301, Pl. LXIII, two figs., 1912.

Based on a pair from the same locality.

Single type here designated: unique, figured, nearly adult ♂ type; Santa Rita Mountains, Arizona, elevation 5,000–8,000 feet, June, 1907; F. H. Snow; University of Kansas Collection.

CORDILLACRIS PIMA.

PROC. ACAD. NAT. SCI. PHILA., 1907, p. 69, figs. 17, 18.

Based on a unique female specimen from the Baboquivari Mountains, Pima County, Arizona, 1906; F. H. Snow; University of Kansas Collection.

PLATYBOTHRUS ALTICOLA.

Ent. News, Vol. XVII, p. 284, 1906.

Described from one male from the Beaver Range Mountains, Beaver and Piute Counties, Utah, elevation 8,000–10,000 feet; Brooklyn Institute of Arts and Sciences Collection.

Arphia canora.

Proc. Acad. Nat. Sci. Phila., 1904, p. 564.

Based on a pair from different localities.

Single type here designated: ♂ type; Salt Lake City, Utah; A. N. S. P. Collection.

Arphia ramona.

Can. Ent., Vol. XXXIV, p. 142, 1902.

Based on a pair from one locality.

Single type here designated: ♂ type; San Diego, California, April 4, 1901; G. W. Dunn; A. N. S. P. Collection.

Hippiscus sierra.

Ent. News, Vol. XVIII, p. 350, 1907.

Described from a unique female taken on Mount Tyndall, Tulare County, California, elevation 12,000 feet; C. F. Baker; A. N. S. P. Collection.

Scirtetica ritensis.

Kan. Univ. Sci. Bull., Vol. V, No. 17, Pl. LXIII, four figs., 1910.

Based on a unique female specimen from the Santa Rita Mountains, Arizona, elevation 5,000–8,000 feet, July, 1907; F. H. Snow; University of Kansas Collection.

Conozoa carinata.

Proc. Acad. Nat. Sci. Phila., 1907, p. 38, figs. 2, 3.

Based on a pair from the same locality.

Single type here designated: figured ♂ type; Carr Canyon, Huachuca Mountains, Cochise County, Arizona, August, 1905; Dr. H. Skinner; A. N. S. P. Collection.

Trimerotropis arenaceus.

Proc. Acad. Nat. Sci. Phila., 1910, p. 13, fig. 1.

Based on a pair from the same locality.

Single type here designated: figured ♂ type; Springfield, Bingham County, Idaho, July 25, 1906; Dr. H. Skinner; A. N. S. P. Collection.

Trimerotropis magnifica.

Proc. Acad. Nat. Sci. Phila., 1907, p. 42, figs. 4, 5.

Described from a unique male specimen from Carr Canyon, Huachuca Mountains, Cochise County, Arizona, August, 1905; Dr. H. Skinner; A. N. S. P. Collection.

TRIMEROTROPIS RUBRIPES.

PROC. ACAD. NAT. SCI. PHILA., 1904, p. 568.

Described from a unique female specimen from Albuquerque, New Mexico, July 15, 1902; Oslar; A. N. S. P. Collection.

TRIMEROTROPIS SNOWI.

Proc. Kan. Acad. Sci., Vol. XIX, p. 223, 1905.

Based on a single female from Congress Junction, Yavapai County, Arizona; F. H. Snow; University of Kansas Collection.

PHRYNOTETTIX TAOSANUS.

PROC. ACAD. NAT. SCI. PHILA., 1902, p. 597.

Described from a single female specimen from the Taos Valley, Taos County, New Mexico; June, 1883; U. S. N. M. Collection.

CONALCÆA HUACHUCANA.

PROC. ACAD. NAT. SCI. PHILA., 1907, p. 48, figs. 6, 7.

Based on a pair from a single locality.

Single type here designated: figured ♂ type; Carr Canyon, Huachuca Mountains, Cochise County, Arizona, September 28, 1908; C. R. Biederman; Hebard Collection.

EOTETTIX HEBARDI.

Ent. News, Vol. XVII, p. 234, figs. 1, 2, 1906.

Based on a unique male from Tyty Plantation, Thomas County, Georgia, January 6, 1906; Hebard; Hebard Collection.

BRADYNOTES EXCELSA.

Ent. News, Vol. XVIII, p. 352, 1907.

Described from a pair from the same locality.

Single type here designated: ♂ type; Mount Tyndall, Tulare County, California, elevation 12,000 feet; C. F. Baker; A. N. S. P. Collection.

MELANOPLUS DESULTORIUS.

PROC. ACAD. NAT. SCI. PHILA., 1907, p. 51, figs. 8, 9.

Described from a pair from the same locality.

Single type here designated: figured ♂ type; Carr Canyon, Huachuca Mountains, Cochise County, Arizona, September 24, 1905; C. R. Biederman; Hebard Collection.

MELANOPLUS STONEI.

Ent. News, Vol. XV, p. 85, 1904.

Based on a pair from a single locality.

Single type here designated: ♂ type; between Harris and White Horse, Burlington County, New Jersey, August 13, 1902; Witmer Stone and Rehn; A. N. S. P. Collection.

APTENOPEDES CLARA.

Ent. News, Vol. XIII, p. 14, 1902.

Described from one male taken at Miami, Dade County, Florida, January 18, 1899; S. N. Rhoads; A. N. S. P. Collection, ex Rehn.

DICHOPETALA LÆVIS.

PROC. ACAD. NAT. SCI. PHILA., 1907, p. 56, fig. 10.

Described from a unique female from Carr Canyon, Huachuca Mountains, Cochise County, Arizona, August, 1905; Dr. H. Skinner; A. N. S. P. Collection.

HORMILIA APACHE.

PROC. ACAD. NAT. SCI. PHILA., 1907, p. 58, figs. 11, 12.

Based on a pair from a single locality.

Single type here designated: figured ♂ type; Carr Canyon, Huachuca Mountains, Cochise County, Arizona, August, 1905; Dr. H. Skinner; A. N. S. P. Collection.

ARETHÆA SELLATA.

PROC. ACAD. NAT. SCI. PHILA., 1907, p. 61, figs. 13, 14.

Described from a single male from Palmerlee, Cochise County, Arizona, July 30, 1905; C. Schaeffer; Brooklyn Institute of Arts and Sciences Collection.

DRYMADUSA ARIZONENSIS.

PROC. ACAD. NAT. SCI. PHILA., 1904, p. 573.

Based on a unique male from Florence, Arizona, 1903; C. R. Biederman; A. N. S. P. Collection.

PLAGIOSTIRA GRACILIS.

Proc. Kan. Acad. Sci., Vol. XIX, p. 227, 1905.

Based on a unique female from Bill Williams Fork, Arizona, August; F. H. Snow; University of Kansas Collection.

STIPATOR GRANDIS.

PROC. ACAD. NAT. SCI. PHILA., 1904, p. 544.

Described from one female from Alta Mira, Tamaulipas, Mexico, June 27, 1903; M. E. Hoag; A. N. S. P. Collection.

Stenopelmatus terrenus.

Ent. News, Vol. XIII, p. 240, 1902.

Based on a unique female from Texas; A. N. S. P. Collection.

Ceuthophilus lamellipes.

Proc. Acad. Nat. Sci. Phila., 1907, p. 78, fig. 19.

Based on a pair from the same locality.

Single type here designated: figured ♂ type; Phœnix, Arizona, November 18, 1903; R. E. Kunzé; Hebard Collection.

Ceuthophilus paucispinosus.

Proc. Kan. Acad. Sci., Vol. XIX, p. 227, 1905.

Described from a unique female from Southern Arizona, August, 1902; F. H. Snow; University of Kansas Collection.

Ceuthophilus tuckeri.

Ent. News, Vol. XVIII, p. 445, text fig., 1907.

Based on a unique male from Lawrence, Kansas, October, at night; E. S. Tucker; University of Kansas Collection.

Pristoceuthophilus marmoratus.

Ent. News, Vol. XV, p. 280, 1904.

Based on a unique male from the mountains near Claremont, California; C. F. Baker; A. N. S. P. Collection.

Phrixocnemis franciscanus.

Proc. Kan. Acad. Sci., Vol. XIX, p. 228, 1905.

Based on a pair from one locality.

Single type here designated: unique ♂ type; Humphrey's Peak, Coconino County, Arizona, at base of mountain, elevation 9,500 feet; F. H. Snow; University of Kansas Collection.

Phrixocnemis hastiferus.

Ent. News, Vol. XIII, p. 241, 1902.

Based on a unique female from Arizona; U. S. N. M. Collection.

Phrixocnemis inhabilis.

Ent. News, Vol. XV, p. 282, 1904.

Described from a unique female specimen taken at St. Louis, Missouri, November 15, 1903; C. L. Heink; Hebard Collection.

Phrixocnemis socorrensis.

Proc. Kan. Acad. Sci., Vol. XIX, p. 229, 1905.

Based on a pair from a single locality.

Single type here designated: unique ♂ type; Magdalena Mountains, Socorro County, New Mexico, August, 1894; F. H. Snow; University of Kansas Collection.

UDEOPSYLLA SERRATA.

Proc. Kan. Acad. Sci., Vol. XIX, p. 230, 1905.

Based on a single male from Southern Arizona, August, 1902; F. H. Snow; University of Kansas Collection.

UDEOPSYLLA VIERECKI.

PROC. ACAD. NAT. SCI. PHILA., 1902, p. 725.

Described from a unique male (?) from Cloudcroft, Otero County, New Mexico, May 27, 1902; H. L. Viereck; A. N. S. P. Collection.

GRYLLUS ALOGUS.

PROC. ACAD. NAT. SCI. PHILA., 1902, p. 726.

Based on a unique female taken at Albuquerque, New Mexico, 1902; T. D. A. Cockerell; A. N. S. P. Collection.

FALCICULA HEBARDI.

Ent. News, Vol. XIV, p. 258, 1903.

Based on a pair from the same locality.

Single type here designated: unique, subsequently figured[25] ♂ type; Thomasville, Georgia, April 17, 1903; Hebard; A. N. S. P. Collection.

PART TWO—SPECIES OF NORTH AMERICAN ORTHOPTERA DESCRIBED BY JAMES A. G. REHN AND MORGAN HEBARD.

ISCHNOPTERA NOTHA.

PROC. ACAD. NAT. SCI. PHILA., 1910, p. 442, fig. 21.

Based on a pair from different localities.

Single type here designated: figured ♂ type; Huachuca Mountains, Arizona, August 22, 1903; Oslar; U. S. N. M. Collection.

TEMNOPTERYX DESERTÆ.

PROC. ACAD. NAT. SCI. PHILA., 1909, p. 116, fig. 1.

Described from a unique female from Johnstone, Valverde County, Texas, July 8, 1907, under boulder on bare desert; Hebard; Hebard Collection.

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[25] *Entomological News*, Vol. XIV, p. 302, 1903.

Ischnoptera insolita.

Proc. Acad. Nat. Sci. Phila., 1910, p. 450, fig. 27.

Described from a pair from different localities.

Single type here designated: figured ♂ type; Shovel Mountain, Texas, June 21, 1901; F. G. Schaupp; A. N. S. P. Collection.

Homœogamia subdiaphana mohavensis.

Proc. Acad. Nat. Sci. Phila., 1909, p. 415.

Based on four males from the same locality.

Single type here designated: ♂; Cottonwood, San Bernardino County, California, September 9, 1907, on train attracted to light; Hebard; Hebard Collection.

Yersinia sophronica.

Proc. Acad. Nat. Sci. Phila., 1908, p. 369, figs. 1, 2.

Based on a unique female specimen from Sonora Road Canyon, Tucson Mountains, Pima County, Arizona, elevation 3,000 feet, July 25, 1907; Hebard; Hebard Collection.

Stagmomantis californica.

Proc. Acad. Nat. Sci. Phila., 1909, p. 416, figs. 1, 2.

Based on a pair from a single locality.

Single type here designated: figured ♀ type; Cottonwood, San Bernardino County, California, September 9, 1907, on train attracted to light; Hebard; Hebard Collection.

Diapheromera (Ceratites) covilleæ.

Proc. Acad. Nat. Sci. Phila., 1909, p. 127, figs. 5, 6, 9.

Based on a pair from one locality.

Single type here designated: unique figured ♂ type; Franklin Mountains, El Paso County, Texas, elevation 4,500 feet, July 9, 1907, on greasewood, *Covillea tridentata;* Rehn; Hebard Collection.

Pseudosermyle tenuis.

Proc. Acad. Nat. Sci. Phila., 1909, p. 121, figs. 2, 3, 4.

Described from a unique male from the Franklin Mountains, El Paso County, Texas, elevation 4,500 feet, July 9, 1907, on wisp of dry grasses; Rehn; Hebard Collection.

Apotettix minutus.

Proc. Acad. Nat. Sci. Phila., 1905, p. 34, Pl. I, figs. 3, 4.

Based on a unique male specimen from Miami, Florida, February 6, 1904, damp spot near river; Hebard; Hebard Collection.

MORSEA CALIFORNICA TAMALPAISENSIS.

PROC. ACAD. NAT. SCI. PHILA., 1909, p. 421, figs. 3, 4.

Described from a pair from one locality.

Single type here designated: figured ♂ type; Mount Tamalpais, Marin County, California, August 23, 1907, on slopes, elevation 1,500-2,100 feet; Hebard; Hebard Collection.

PARAPOMALA ACRIS.

PROC. ACAD. NAT. SCI. PHILA., 1908, p. 371, figs. 3, 4.

Described from a unique male from Railroad Pass, Cochise County, Arizona, July 23, 1907; Hebard; Hebard Collection.

PARAPOMALA PERPALLIDA.

PROC. ACAD. NAT. SCI. PHILA., 1908, p. 373, figs. 5, 6.

Based on a unique male from the Bright Angel Trail, Grand Canyon of the Colorado, Coconino County, Arizona, elevation 3,750 feet, September 12, 1907; Hebard; Hebard Collection.

AMPHITORNUS NANUS.

PROC. ACAD. NAT. SCI. PHILA., 1908, p. 376, fig. 7.

Described from a single male from the Grand Canyon of the Colorado, Coconino County, Arizona, elevation 7,000 feet, September 11, 1907; Hebard; Hebard Collection.

CORDILLACRIS APACHE.

PROC. ACAD. NAT. SCI. PHILA., 1909, p. 139, figs. 10, [11].

Based on a pair from a single locality.

Single type here designated: figured ♀ type; Silver City, Grant County, New Mexico, July 20, 1907; Rehn and Hebard; Hebard Collection.

CORDILLACRIS GRINNELLI.

PROC. ACAD. NAT. SCI. PHILA., 1909, p. 425, fig. 8.

Described from a single female from the South Fork of the Santa Ana River in the San Bernardino Mountains, California, elevation 6,200 feet, July 6, 1906; Dr. J. Grinnell; A. N. S. P. Collection.

CLINOCEPHALUS PULCHER.

PROC. ACAD. NAT. SCI. PHILA., 1905, p. 36, Pl. I, figs. 1, 2.

Based on a pair from a single locality.

Single type here designated: figured ♂ type; Miami, Florida, July 20, 1903; W. S. Dickinson; Hebard Collection.

HORESIDOTES PAPAGENSIS.

PROC. ACAD. NAT. SCI. PHILA., 1908, p. 379, fig. 8.

Described from a unique female from the Sonora Road Canyon, Tucson Mountains, Pima County, Arizona, elevation 3,000 feet, July 25, 1907; Hebard; Hebard Collection.

AGENEOTETTIX SIERRANUS.

PROC. ACAD. NAT. SCI. PHILA., 1909, p. 429, figs. 9, [10].

Based on a pair from one locality.

Single type here designated: figured ♂ type; Summit House, Madera County, California, September 3, 1907; Hebard; Hebard Collection.

CHORTOPHAGA AUSTRALIOR.

PROC. ACAD. NAT. SCI. PHILA., 1910, p. 589, figs. 1, 2.

Based on a pair from the same locality.

Single type here designated: figured ♀ type; Thomasville, Georgia, December 10, 1902; Hebard; A. N. S. P. Collection.

ENCOPTOLOPHUS ROBUSTUS.

PROC. ACAD. NAT. SCI. PHILA., 1909, p. 435, figs. 11, 12.

Based on a unique female from the Los Angeles River, Los Angeles, California, August 24, 1907; O. Poling; Hebard Collection.

TRIMEROTROPIS BILOBATA.

PROC. ACAD. NAT. SCI. PHILA., 1906, p. 362, figs. 11, [12].

Described from a pair from a single locality.

Single type here designated: figured ♀ type; Antlers, Mesa County, Colorado, August 15, 1904; Hebard; Hebard Collection.

CIRCOTETTIX RABULA.

PROC. ACAD. NAT. SCI. PHILA., 1906, p. 393, figs. 13, [14].

Based on a pair from a single locality.

Single type here designated: figured ♀ type; summit of hills at head of Mammoth Hot Springs, Yellowstone National Park, Wyoming, elevation 7,000 feet, August 8, 1904; Hebard; Hebard Collection.

CIRCOTETTIX SPLENDIDUS.

PROC. ACAD. NAT. SCI. PHILA., 1909, p. 456, figs. 13, [14].

Based on a pair from the same locality.

Single type here designated: unique, figured ♂ type; Mount

Lowe, San Gabriel Mountains, California, elevation 5,300 feet, August 8, 1907; Hebard; Hebard Collection.

Campylacantha lamprotata.

Proc. Acad. Nat. Sci. Phila., 1909, p. 157, figs. 12, 13, 14.

Based on a unique male from Hijito, Valverde County, Texas, July 8, 1907; Hebard; Hebard Collection.

Podisma oreas.

Proc. Acad. Nat. Sci. Phila., 1906, p. 402, figs. 15, 16.

Based on a pair from a single locality.

Single type here designated: unique, figured ♂ type; summit of foothills of Gallatin Range, Mammoth Hot Springs, Yellowstone National Park, Wyoming, elevation 7,000 feet, August 5, 1904; Hebard; Hebard Collection.

Amblycorypha floridana.

Proc. Acad. Nat. Sci. Phila., 1905, p. 42, Pl. I, fig. 5.

Based on a pair from different localities.

Single type here designated: figured ♀ type; Miami, Florida, July 20, 1903; W. S. Dickinson; Hebard Collection.

Microcentrum rostratum.

Proc. Acad. Nat. Sci. Phila., 1905, p. 43, Pl. I, figs. 6, 7.

Described from a single female from Miami, Florida, March 16, 1903; Hebard; Hebard Collection.

Conocephalus lyristes.

Proc. Acad. Nat. Sci. Phila., 1905, p. 45, Pl. I, figs. 8, 9.

Based on a unique male specimen from Chokoloskee, Monroe County, Florida; Hebard Collection.

Conocephalus melanorhinus.

Proc. Acad. Nat. Sci. Phila., 1907, p. 304, figs. 1, 2.

Described from a unique female from Cedar Keys, Levy County, Florida, August 12, 1905; Hebard; Hebard Collection.

Conocephalus hoplomachus.

Proc. Acad. Nat. Sci. Phila., 1905, p. 46, Pl. I, figs. 10, 11.

Based on a single female specimen from Chokoloskee, Monroe County, Florida, May; Hebard Collection.

ORCHELIMUM FIDICINIUM.

PROC. ACAD. NAT. SCI. PHILA., 1907, p. 309, figs. 7, 8.

Described from a pair from a single locality.

Single type here designated: figured ♂ type; Cedar Keys, Levy County, Florida, August 15, 1905, in flooded salt marsh; Hebard; Hebard Collection.

ORCHELIMUM MILITARE.

PROC. ACAD. NAT. SCI. PHILA., 1907, p. 311, fig. 10.

Based on a pair from the same locality.

Single type here designated: unique, figured ♂ type; Gainesville, Alachua County, Florida, August 17, 1905, marshy sink-hole in pine woods; Rehn and Hebard; Hebard Collection.

ORCHELIMUM MOLOSSUM.

PROC. ACAD. NAT. SCI. PHILA., 1907, p. 307, figs. 4, 5.

Based on a pair from different localities.

Single type here designated: figured ♂ type; Pablo Beach, Duval County, Florida, August 13, 1905, in grass along railroad tracks; Rehn and Hebard; Hebard Collection.

AGLAOTHORAX SIERRANUS.

PROC. ACAD. NAT. SCI. PHILA., 1909, p. 476, figs. 15, 16, 19.

Based on a pair from the Yosemite National Park.

Single type here designated: figured ♂ type; Yosemite Valley, Yosemite National Park, California, elevation 4,500 feet, September 1, 1907, hiding against bark on trunk of conifer several feet from ground; Hebard; Hebard Collection.

ATELOPLUS MACROSCELUS.

PROC. ACAD. NAT. SCI. PHILA., 1909, p. 169, fig. 17.

Described from a unique female specimen from El Paso, Texas, July 11, 1907, on Greasewood, *Covillea tridentata;* Rehn; Hebard Collection.

CEUTHOPHILUS VIRGATIPES.

PROC. ACAD. NAT. SCI. PHILA., 1904, p. 798.

Based on a pair from a single locality.

Single type here designated: ♂ type; Thomasville, Georgia, August 13, 1903, in heavy swamp; for Hebard by Emmanuel, (negro); Hebard Collection.

LIPHOPLUS ZEBRA.

PROC. ACAD. NAT. SCI. PHILA., 1905, p. 49, Pl. I, fig. 12.

Described from a single male taken at Miami, Florida, February 6, 1904; Hebard; Hebard Collection.

NEMOBIUS PALUSTRIS AURANTIUS.

PROC. ACAD. NAT. SCI. PHILA., 1910, p. 597.

Described from a pair from the same locality.

Single type here designated: ♂ type; Thomasville, Georgia, December 6, 1903, in sphagnum mosses in swampy spot; Hebard; Hebard Collection.

SECTION THREE.

THE SPECIES DESCRIBED BY PROFESSOR LAWRENCE BRUNER IN THE BIOLOGIA CENTRALI-AMERICANA AND LOCATED IN THE HEBARD COLLECTION EX BRUNER.

One hundred and sixteen of the one hundred and seventy-three species of Acrididæ described by Professor Bruner in the Orthoptera portion of the Biologia Centrali-Americana[26] are located in the Hebard Collection ex Bruner. In this series are included all but one of the thirty-four species described by him in that work whose range of distribution is known to extend north of the Mexican boundary. The authors are at present mainly interested in locating the single types of species which are found in North America north of the Mexican line, but the present paper treats all of those species whose single types should be located in the Hebard Collection ex Bruner. The types of the remaining fifty-seven species should be found distributed as follows: twenty-four in the Biologia Centrali-Americana Collection in the British Museum; sixteen in Professor Bruner's South American Collection; six in the Scudder Collection in the Museum of Comparative Zoology at Cambridge; five in the United States National Museum; four in the Carnegie Museum in Pittsburgh and two in the Museum of Geneva. The nomenclature given in the original description is here used throughout, as this paper is not intended to be in any way revisionary.

PAROPOMALA PALLIDA (p. 40).

Based on three female specimens from a single locality.

Single type here designated: ♀; Indio, California; H. F. Wickham.

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[26] *Biologia Centrali-Americana*, Orthoptera, II, pp. 19–342, 1901–1908.

PAROPOMALA DISSIMILIS (p. 41).

Based on a single female from Southern California or Northern Mexico; Gustav Eisen.

PAPAGOA ARIZONENSIS (p. 42).

Described from a unique male from Southern California or Northern Mexico; G. W. Dunn.

SYRBULA PACIFICA (pp. 43, 44).

Based on two females from the same locality.

Single type here designated: ♀; Tepic, Mexico; Eisen.

SYRBULA MODESTA (pp. 44, 46).

Based on two pairs from a single locality.

Single type here designated: ♂; Grand Cañon of the Colorado River, Arizona, [July 9, 1892][27]; C. H. T. Townsend.

ACROLOPHITUS VARIEGATUS (pp. 47, 48) Tab. I, fig. 3.

Based on an unspecified number of individuals from two localities.

Single type here designated: figured ♂; Carrizo Springs, Dimmit County, Texas, [June, 1885]; A. Wadgymar.

ACROLOPHITUS UNIFORMIS (p. 47).

Described from an unspecified number of specimens from various localities.

Single type here designated: ♀; [Sterling, Colorado, July].

MACHÆROCERA PACIFICA (pp. 49, 51).

Based on numerous specimens of both sexes from one locality.

Single type here designated: ♂; Tepic, Mexico, not far from San Blas on Pacific Slope; Eisen.

SILVITETTIX COMMUNIS (p. 56).

Based on numerous specimens from three localities.

Single type here designated: ♂; Monte Redondo, Costa Rica, March, [1902]; Professor Lawrence Bruner.

OCHROTETTIX SALINUS (p. 56) Tab. I, figs. 4, 4*a*.

Described from an unspecified number of individuals from a single locality.

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[27] In the present paper all authentic information given, which was not contained in the original description, is enclosed in brackets.

Single type here designated: figured ♂: Salina Cruz, Tehuantepec, Mexico, [December, 1898]; C. C. Deam.

LEUCONOTUS BIOLLEYI (p. 57).

Based on five males from two localities.

Single type here designated: ♂; Rio Grande, Costa Rica, elevation 1,800 feet, [March 6, 1902]; Bruner.

OPEIA IMPERFECTA (p. 59).

Described from an unspecified number of specimens from three localities.

Single type here designated: ♂; Jimulco, Mexico, November, [1887]; Bruner.

OPEIA MEXICANA (pp. 59, 60).

Described from a unique female specimen from Tlalpam, near City of Mexico, Mexico, [November, 1887]; Bruner.

OPEIA PALMERI (pp. 59, 61).

Described from a pair from one locality.

Single type here designated: unique ♀; Sierra de San Miguelito, San Luis Potosi, Mexico; E. Palmer.

AMBLYTROPIDIA COSTARICENSIS (pp. 63, 66).

Based on a series of specimens from two localities.

Single type here designated: ♂; San José, Costa Rica; Prof. P. Biolley.

AMBLYTROPIDIA ELONGATA (pp. 63, 68).

Described from a single female from Tepic, Mexico.

THYRIPTILON VITRIPENNE (p. 69).

Based on fourteen males and six females from a single locality.

Single type here designated: ♂; Valladolid, Yucatan; Gaumer.

SISANTUM NOTOCHLORIS (p. 69) Tab. I, figs. 11, 11*a*.

Based on five males and two females from one locality.

Single type here designated: figured ♀; Medellin, Vera Cruz, Mexico, September; Rev. T. Heyde.

ORPHULA MERIDIONALIS (p. 73).

Based on a single female from Pozo Azul, Costa Rica, May or June, 1902; M. A. Carriker, Jr.

ORPHULELLA GRAMINEA (pp. 75, 78).

Based on numerous specimens from one locality.
Single type here designated: ♂; Phœnix, Arizona; Kunzé.

ORPHULELLA MERIDIONALIS (pp. 77, 81).

Based on an unspecified number of specimens from one locality.
Single type here designated: ♂; [San José]; Costa Rica; Biolley.

ORPHULELLA COSTARICENSIS (pp. 77, 82).

Described from an unspecified number of specimens from one locality.
Single type here designated: ♂; San José, Costa Rica; [Biolley].

LINOCERATIUM BOUCARDI (p. 84).

Based on a series of six specimens from three localities.
Single type here designated: ♂; Panama; Gustave Boucard.

DICHROMORPHA MEXICANA (pp. 86, 87) Tab. I, figs. 18, 18*a*.

Based on nine specimens from two localities.
Single type here designated: figured ♀; Tepic, Mexico.

DICHROMORPHA LONGIPENNIS (pp. 86, 87).

Based on one male, six females and two nymphs from Mexico.
Single type here designated: ♀; [Tepic], Mexico.

GOMPHOCERUS MERIDIONALIS (p. 93).

Described from a unique female from Cuernavaca, Morelos, Mexico, January [4, 1899]; Deam.

BOOPEDON FUSCUM (pp. 95, 96).

Based on a series of specimens from three localities.
Single type here designated: ♂; Nogales, Arizona; J. G. Lemmon.

BOOPEDON SAVANNARUM (pp. 95, 97).

Based on a series of specimens from one region.
Single type here designated: ♂; West Point, Nebraska. September, 1884.

BOOPEDON DIABOLICUM (pp. 95, 98) Tab. I, figs. 21, 21*a*.

Based on a unique female from Tepic, Mexico; Eisen.

BOOPEDON FLAVIVENTRIS (pp. 95, 98).

Based on an unstated series of both sexes from two localities.
Single type here designated: ♂; Tepic, Mexico.

Plectrotettix calidus (p. 101).

Based upon an unstated number of specimens from four localities.

Single type here designated: ♂; Cuernavaca, Morelos, Mexico; O. W. Barrett.

Plectrotettix excelsus (pp. 101, 102).

Described from two females from different localities.

Single type here designated: ♀; Tlalpam, near City of Mexico; Barrett.

Zapata brevipennis (p. 103) Tab. I, figs. 22, 22*a*.

Based on a pair from different localities.

Single type there designated: unique figured ♀; Lerdo, Durango, Mexico, November, [1887]; Bruner.

Stirapleura salina (pp. 106, 107).

Described from two females from the same locality.

Single type here designated: ♀; Salina Cruz, Tehuantepec, Mexico, December, [1898]; Deam.

Stirapleura meridionalis (pp. 106, 107).

Described from a pair from one locality.

Single type here designated: unique ♀; Salina Cruz, Tehuantepec, Mexico, December, [1898]; Deam.

Stirapleura brachyptera (pp. 105, 108).

Described from a unique female from Oaxaca, Mexico, [June 28]; Deam.

Ageneotettix australis (pp. 109, 110).

Based on a series of specimens from a single locality.

Single type here designated: ♀; Phœnix, Arizona; Kunzé.

Ageneotettix curtipennis (p. 109).

Based on an unspecified number of specimens from southern Colorado.

Single type here designated: ♀; [Durango], Colorado, [August 7, 1899].

Aulocara brevipenne (p. 111).

Described from a unique male from Comancho, Zacatecas, Mexico. November, [1887]; Bruner.

GONIATRON PLANUM (p. 113) Tab. I, figs. 20, 20*a*, *b*.

Based on a single figured male from Comancho, Zacatecas, Mexico, November, [1887]; Bruner.

ARPHIA IMPERFECTA (pp. 121, 126).

Based on a single female specimen from Tlalpam, near Mexico City, Mexico, November, [1887]; Bruner.

ARPHIA CALIDA (pp. 121, 127).

Described from an unspecified number of specimens from one locality.

Single type here designated: ♂; Zacatecas, Mexico, November, [1887]; Bruner.

ARPHIA CRASSA (pp. 121, 128).

Based on a series of specimens from three localities.

Single type here designated: ♀; Southern Arizona; Lemmon.

ARPHIA TOWNSENDI (pp. 122, 129).

Described from an unstated number of specimens from two localities.

Single type here designated: ♂; Colonia Garcia, Chihuahua, Mexico; Townsend.

ARPHIA PULCHRIPENNIS (pp. 122, 131).

Described from a single male specimen from the vicinity of Los Angeles, California; Koebele.

ARPHIA PALLIDIPENNIS (pp. 122, 131).

Described from a pair from different localities.

Single type here designated: unique ♀; Eslava, Dist. Fed., Mexico; Barrett.

ARPHIA DECEPTA (pp. 123, 132).

Based on an unindicated series from four localities.

Single type here designated: ♀; Orizaba, Mexico, [November, 1887]; Bruner.

ARPHIA KOEBELEI (pp. 123, 133).

Based on a single male specimen from San Mateo County, California, [May]; Koebele.

CHORTOPHAGA MERIDIONALIS (pp. 135, 136).

Based on an unspecified number of specimens from a single locality

Single type here designated: ♀; slopes of the Volcan de Irazu, Costa Rica, elevation 7,500 to 9,000 feet; Biolley.

ENCOPTOLOPHUS MONTANUS (pp. 139, 140).

Based on an unindicated number of specimens (probably one pair) from a single locality.

Single type here designated: ♂; Bozeman, Montana, [September 10, 1904]; R. A. Cooley.

ENCOPTOLOPHUS FULIGINOSUS (pp. 139, 141).

Described from a large series of both sexes from one locality.

Single type here designated: ♂; Colonia Garcia, Chihuahua, Mexico, [September, 1899]; Townsend.

ENCOPTOLOPHUS HERBACEUS (pp. 139, 141) Tab. II, fig. 13.

Based on a series from one locality.

Single type here designated: figured ♀, Chapultepec, Dist. Fed., Mexico, [November, 1887]; Bruner.

ENCOPTOLOPHUS CALIFORNICUS (pp. 139, 142).

Based on an unspecified series from one locality.

Single type here designated: ♂; Los Angeles, California, [1888], D. W. Coquillett.

ENCOPTOLOPHUS TEXENSIS (pp. 139, 142).

Based on an unspecified number of specimens from six localities.

Single type here designated: ♂; Carrizo Springs, Texas, October, 1884; Wadgymar.

HIPPISCUS AUSTRALIS (pp. 151, 157).

Described from a series from three localities.

Single type here designated: ♂; Eslava, Dist. Fed., Mexico; Barrett.

LEPRUS INTERIOR (pp. 158, 160).

Based on an unspecified number of specimens from one locality.

Single type here designated: ♂; Salt Lake Valley, Utah, [September, 1883].

DISSOSTEIRA PICTIPENNIS (pp. 162, 165).

Described from a single female from California, probably near Indio; Geo. L. Forge.

DISSOSTEIRA PLANIPENNIS (pp. 162, 164).

Based on a single specimen ("taken between San Diego and San Bernardino, Southern") California; La Forge.

TRACHYRHACHIS COMPACTA (pp. 174, 175).

Described from an unspecified number of specimens (probably one pair) from one locality.

Single type here designated: ♀; Silver City, New Mexico, July, [1884; Charles H. Marsh].

TRACHYRHACHIS INCONSPICUA (pp. 174, 176).

Described from three specimens from one locality.

Single type here designated: ♂; Zacatecas, Mexico, November, [1887]; Bruner.

TRACHYRHACHIS TOWNSENDI (pp. 174, 176).

Described from a pair from the same locality.

Single type here designated: unique ♂; Colonia Garcia, Chihuahua, Mexico; Townsend.

TRACHYRHACHIS OCCIDENTALIS (p. 174).

Based on an unstated number of specimens (probably a single male) from one locality.

Single type here designated: ♂; San Francisco [County, California, June].

TRIMEROTROPIS TOWNSENDI (p. 180).

Described from numerous specimens of both sexes from a single locality.

Single type here designated: ♂; Colonia Garcia, Chihuahua, Mexico; Townsend.

ANCONIA GRISEA (pp. 185, 186).

Described from a unique male from Antelope Valley, California; Koebele.

ANCONIA CÆRULEIPENNIS (pp. 185, 186).

Described from a single female from Hawthorne, Nevada, [June]; H. F. Wickham.

RAMONA DESERTICOLA (p. 187).

Based on a single female specimen from Indio, California; Wickham.

BRACHYSTOLA PONDEROSA (pp. 193, 194).

Described from two pairs from a single locality.

Single type here designated: ♂; Guaymas, Mexico, [November, 1893; Eisen].

BRACHYSTOLA INTERMEDIA (pp. 193, 194).

Based on three female specimens from two localities.

Single type here designated: ♀; Mazatlan, Mexico; Woodruff.

BRACHYSTOLA EISENI (pp. 193, 196).

Based on a pair from the same locality.

Single type here designated: ♂; Tepic, Mexico; Eisen.

CALAMACRIS CALIFORNICA (pp. 200, 201) Tab. IV, figs. 25, 25*a*.

Described from an unspecified number of specimens from one locality.

Single type here designated: figured ♂; San José del Cabo, Lower California.

CALAMACRIS MEXICANA (pp. 200, 201) Tab. IV, fig. 26.

Described from a unique figured female from Patrocinio, Lower California, [April, 1889]; Charles D. Haines.

CALAMACRIS PALMERI (pp. 200, 202).

Described from an unspecified number of specimens from one locality.

Single type here designated: ♀; Cape St. Lucas, Lower California; Palmer.

CALAMACRIS OCULATA (pp. 200, 202).

Based on a unique male from (extreme Southern) Arizona.

SPHENARIUM BOLIVARI (pp. 203, 205).

Described from two males from different localities.

Single type here designated: ♂; Salina Cruz, Tehuantepec, Mexico, [December, 1898]; Deam.

SPHENARIUM MARGINATUM (pp. 204, 205).

Based on an unstated number of specimens from three localities.

Single type here designated: ♂; Orizaba, Mexico, [November, 1887]; Bruner.

SPHENARIUM RUGOSUM (pp. 204, 206).

Based on an unstated series (probably a pair) from a single locality.

Single type here designated: ♂; Cuernavaca, Morelos, Mexico, January [4, 1899]; Deam.

SPHENARIUM BARRETTI (pp. 204, 206).

Based on a single male specimen from Rio Cocula, Guerrero, Mexico, December; Barrett.

SPHENARIUM PLANUM (pp. 204, 207).

Described from a pair from one locality.

Single type here designated: unique ♂; Tehuantepec, Mexico, [November].

SPHENARIUM MINIMUM (pp. 204, 207).

Described from a unique specimen from Jalapa, Vera Cruz, Mexico, [December]; Barrett.

SPHENARIUM AFFINE (p. 207).

Described from a pair from one locality.

Single type here designated: unique ♂;[28] Orizaba, Mexico, [November, 1887; Bruner].

DRACOTETTIX CALIFORNICUS (p. 226).

Based on an unstated number of females (probably five) from four localities.

Single type here designated: ♀; Santa Cruz Mountains, California.

TÆNIOPODA MAXIMA (pp. 233, 235).

Based on an unstated series from a single locality.

Single type here designated: ♂; Limon, Costa Rica; Carriker.

TÆNIOPODA OBSCURA (pp. 233, 235) Tab. II, figs. 21, 21*a*.

Based on an unspecified number of specimens from two localities.

Single type here designated: figured ♂; Temax, Northern Yucatan; Gaumer.

TÆNIOPODA BICRISTATA (pp. 233, 236).

Described from a single female from Mat. (possibly Matamoras, Puebla), Mexico.

NAUTIA CONSPERSIPES (pp. 243, 244).

Based on an unspecified number of specimens from one locality.

Single type here designated: ♀; Chontales, Nicaragua.

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[28] In giving the location of the male and female types Bruner has evidently confused the sexes.

TÆNIOPHORA FEMORATA (p. 245).

Described from an unstated number of specimens from one locality.

Single type here designated: ♂; Pozo Azul, Costa Rica; Carriker.

RHICNODERMA GLABRA (pp. 248, 249).

Based on two females from one locality.

Single type here designated: ♀; Pozo Azul, Costa Rica; Underwood and Carriker.

RHICNODERMA PUGNAX (pp. 248, 250).

Based on an unstated number of specimens (probably one male) from a single locality.

Single type here designated: ♂; Vera Cruz, Mexico, [January, 1892]; Heyde.

ARNILIA MARSCHALLI (pp. 255, 256).

Described from a series from two localities.

Single type here designated: ♂: Juan Viñas, Costa Rica, March, [1902]; Bruner.

ARNILIA PROPINQUA (pp. 255, 257).

Based on an unspecified number of specimens from three localities.

Single type here designated: ♀; Amatitlan, Guatemala, [February]; J. S. Hine.

INUSIA NANA (pp. 259, 260).

Based on a pair from different localities.

Single type here designated: unique ♂; Limon, Costa Rica; Carriker.

INUSIA BICOLOR (pp. 259, 260).

Based on an unstated series from eight localities.

Single type here designated: ♂; Los Amates, Guatemala, [February 26]; Hine.

INUSIA INORNATIPES (pp. 259, 260).

Described from several specimens from one locality.

Single type here designated: ♂; San Rafael, Vera Cruz, Mexico; Townsend.

PROCTOLABUS BRACHYPTERUS (pp. 265, 266) Tab. III, figs. 19, 19*a*.

Based on a male and female type from one locality.

Single type here designated: figured ♂: Jalisco, Mexico; Schumann.

LEIOSCAPHEUS GRACILICORNIS (p. 267).

Based on several specimens (probably all females) from a single locality.

Single type here designated: ♀; Pozo Azul, Costa Rica; Carriker.

ANNICERIS MERIDIONALIS (pp. 269, 271).

Based on an unstated number of specimens (probably one pair) from a single locality.

Single type here designated: ♂; Pozo Azul, Costa Rica; Carriker.

ANNICERIS APICALIS (pp. 269, 271).

Based on two males and three females from a single locality.

Single type here designated: ♂; San José, Costa Rica; Underwood.

PSILOTETTIX OBESUS (p. 276) Tab. IV, figs. 12, 12*a*.

Based on one figured adult female from Sierra Laguna (Lower California, Mexico?); Eisen.

ARISTIA DEPRESSICORNIS (p. 277).

Based on a single immature [female] specimen from Juan Viñas, Costa Rica, March, [1902]; Bruner.

LEPTOMERINTHOPHORA SMARAGDIPES (p. 287).

Based on several specimens of both sexes from a single locality.

Single type here designated: ♂; Pozo Azul, Costa Rica; Carriker.

LEPTOMERINTHOPHORA FLAVOVITTATA (pp. 287, 288).

Described from an unspecified number of specimens (probably one pair) from a single locality.

Single type here designated: ♂; Juan Viñas, Costa Rica, [March, 1902]; Bruner.

LEPTOMERINTHOPHORA MODESTA (pp. 287, 288).

Based on an unstated number of specimens from a single locality.

Single type here designated: ♂; Monte Redondo, Costa Rica, [March, 1902]; Bruner.

OMMATOLAMPIS ANNULICORNIS (p. 290).

Described from a single female specimen from Pozo Azul, Costa Rica; Carriker.

ŒDOMERUS CORALLIPES (p. 293) Tab. IV, figs. 14, 14*a*.

Described from two females from a single locality.

Single type here designated: figured ♀; San José del Cabo, Lower California, [April, 1889]; Haines.

SCHISTOCERCA VITTAFRONS (p. 298).

Described from an unstated number of specimens (probably a single pair) from one locality.

Single type here designated: ♂; Boruca, Costa Rica, July; Carriker.

DASYSCIRTUS OLIVACEUS (p. 303).

Based on a single male from Cuernavaca, Morelos, Mexico, January 4, [1899]; Deam.

CYCLOCERCUS GRACILIS (p. 307).

Based on two males from one locality.

Single type here designated: ♂; Tampico, Mexico, December, [1906].

CALOTETTIX BICOLORIPES (p. 309).

Based on an unstated number of specimens (probably a unique male) from one locality.

Single type here designated: ♂; Victoria, Tamaulipas, Mexico; Barrett.

CALOTETTIX FLAVOPICTUS (pp. 309, 310).

Described from three females from a single locality.

Single type here designated: ♀; Montelovez, Coahuila, Mexico, [September 20]; Palmer.

CALOTETTIX OBSCURUS (pp. 309, 311).

Based on a single male from Tampico, Mexico, December, [1906].

AGRŒCOTETTIX MODESTUS (p. 312) Tab. IV, figs. 13, 13*a*.

Based on a single female from Villa Lerdo, Durango, Mexico, November, [1887]; Bruner.

MELANOPLUS PICTURATUS (p. 318).

Described from a single female from Colonia Garcia, Chihuahua, Mexico; Townsend.

TEINOPHAUS SAUSSUREI (p. 332) Tab. IV, figs. 3, 3*a*, 4, 4*a*.

Based on one male and two females from two localities.

Single type here designated: figured ♂ of pair taken in coitu (unique); Atoyac, Vera Cruz, Mexico, [November, 1887]; Bruner.

RHACHICREAGRA PALLIPES (pp. 339, 340).

Based on a pair and three nymphs from one locality.

Single type here designated: unique adult ♂; Juan Viñas, Costa Rica, March, [1902]; Bruner.

RHACHICREAGRA ÆRUGINOSA (pp. 339, 340).

Described from a single female from Limon, Costa Rica; Carriker.

RHACHICREAGRA GRACILIS (pp. 339, 340).

Based on a considerable series, particularly of males, from a single locality.

Single type here designated: ♂; Juan Viñas, Costa Rica, [March, 1902]; Bruner.

SECTION FOUR.

In the present section the single types are designated of all of the North American species of Orthoptera described by Professor Lawrence Bruner which have not been selected previously in Sections I and III. Section IV is divided into four parts; the first three treating the species described in three of Professor Bruner's larger papers, and the fourth treating those species described in various short papers from 1876 to 1905. The single types of forty-three species are located in the present section; thirty-eight are in the Hebard Collection ex Bruner; four in the United States National Museum and one in the collection of the Museum of Comparative Zoology at Cambridge.

PART I—"SOME NEW COLORADO ORTHOPTERA," BY LAWRENCE BRUNER. (Bulletin 94, Report of Entomologist, Colorado Experiment Station for 1903, pp. 57–67, 1904.)

In the paper now before us we find the entire first series of typical material retained by the author. The single types are therefore all in the Hebard Collection ex Bruner. No figures are given in the paper under consideration, and the material, if belonging to the typical series, is labelled "TYPE."

NEMOBIUS BREVICAUDUS (p. 57).

Based on a pair from the same locality.

Single type here designated: unique ♂; Fort Collins, Colorado, October 4, 1901.

CEUTHOPHILUS ARIDUS (p. 57).

Described from a unique male; Grand Junction, Colorado, November 17, [1902].

AGENEOTETTIX OCCIDENTALIS (p. 58).

Described from an unspecified number of specimens from Colorado west of the main range.

Single type here designated: ♂; [Glenwood Springs], Colorado, September [15, 1903].

ENCOPTOLOPHUS COLORADENSIS (p. 58).

Described from one male and two females from a single locality.

Single type here designated: unique ♂; Fort Collins, Colorado, [August 31, 1898]; [L. Bruner].

TRIMEROTROPIS INCONSPICUA (p. 59).

Based on an unspecified number of individuals from four localities.

Single type here designated: ♂; Palisade, Colorado, July [8, 1901].

ÆOLOPLUS MINOR (p. 60).

Based on a series of both sexes from a single locality.

Single type here designated: ♂; Delta, Colorado, July 13, 1901.

HESPEROTETTIX GILLETTEI (p. 61).

Based on an unspecified number of specimens from four localities.

Single type here designated: ♂; Rifle, Colorado, July 25, [1900]; (specimen has wings one-half as long as abdomen).

HESPEROTETTIX COLORADENSIS (p. 61).

Based on a pair from different localities.

Single type here designated: unique ♂; Durango, Colorado, August 7, [1899].

MELANOPLUS SANGUINEUS (p. 63).

Based on a series of both sexes from two localities.

Single type here designated: ♂; Lamar, Colorado, [September 10, 1898].

MELANOPLUS TRISTIS (p. 64).

Based on three males and five females from three localities.

Single type here designated: ♂; Durango, Colorado, August [3, 1900].

MELANOPLUS FLABELLIFER BREVIPENNIS (p. 65).

Described from six males and two females from two localities.

Single type here designated: ♂; Palisade, Colorado, July 8, 1901.

MELANOPLUS DIMIDIPENNIS (p. 66).

Based on a unique male; Fort Collins, Colorado, August 16, [1898].

PART II.—"TEN NEW SPECIES OF ORTHOPTERA FROM NEBRASKA—NOTES ON HABITS, WING VARIATION, ETC.," BY LAWRENCE BRUNER. (*Canadian Entomologist*, Vol. XXIII, pp. 36–40, 56–59, 70–73. 1891.)

Practically the entire series of Orthoptera used in the preparation of the paper before us is in the Hebard Collection ex Bruner, and all of the single types are there located. There are no figures accompanying this paper and typical material is labelled "TYPE" indiscriminately.

CYCLOPTILUS BOREALIS (p. 37).

Described from a series of specimens from two localities.

Single type here designated: ♀; Lincoln, Nebraska, September 15, 1888 (taken on margins of large salt basin on sandy soil); L. Bruner.

CEUTHOPHILUS PALLESCENS (p. 37).

Described from one female and one immature male from two localities.

Single type here designated: unique ♀; 17 miles north of Harrison, Sioux County, Nebraska (taken in shallow well).

UDEOPSYLLA COMPACTA (p. 38).

Based on an unspecified number of specimens from three States.

Single type here designated: ♀; [Barbour County], Kansas, [1886]; [F. W. Cragin].

XIPHIDIUM MODESTUM (p. 56).

Based on a series of specimens from five areas.

Single type here designated: ♀; [West Point], Nebraska, [September 4].

XIPHIDIUM NIGROPLEURUM (p. 58).

Described from a series of specimens taken in Eastern Nebraska.

Single type here designated: ♂; [West Point], Nebraska, [September 1].

ORCHELIMUM GRACILE[29] (p. 70).

Based on an unspecified number of specimens from Nebraska.

Single type here designated: ♂; West Point, Nebraska, [September 5].

ORCHELIMUM GLADIATOR (p. 71).

Described from two females taken in the same locality.

Single type here designated: ♀; West Point, Nebraska, September, 1886 (taken on flowers of golden-rod, *Solidago rigida*); L. Bruner.

ORCHELIMUM MINOR (p. 72).

Described from a single female; District of Columbia, [September 15, 1884].

CONOCEPHALUS NEBRASCENSIS (p. 72).

Based on an unspecified number of specimens from three States.

Single type here designated: ♂; [West Point], Nebraska, [August, 1887].

AMBLYCORYPHA SCUDDERÆ (p. 73).

Described from an unspecified number of individuals from eastern Nebraska.

Single type here designated: ♀; [Omaha], Nebraska, [September].

PART III.—"FIRST CONTRIBUTION TO THE KNOWLEDGE OF THE ORTHOPTERA OF KANSAS," BY LAWRENCE BRUNER. (*Bulletin of the Washburn College Laboratory of Natural History*, Vol. IV, No. 4, pp. 125–139, 1885.)

The entire series of typical material, with the exception of one specimen, used in the descriptions of new species in the paper here under consideration, is in the Hebard Collection ex Bruner, and all of the single types are there located. No figures are given in this paper and all typical material is labelled "TYPE."

GRYLLOTALPA PONDEROSA (p. 126).

Described from one female; Labette County, Kansas; Dr. Newlon.

DAIHINIA GIGANTEA (p. 127).

Based on a single male; Labette County, Kansas; Dr. Newlon.

[29] Bruner (*Ent. News*, III, p. 264, 1892) replaced this specific name with *delicatum* in consequence of Harris's previous use of the name for another species of the same genus.

THYREONOTUS CRAGINI (p. 129).

Based on a unique female; Barbour County, Kansas; Cragin.

THYREONOTUS SCUDDERI (p. 129).

Based on two pairs from two localities.

Single type here designated: ♂; Barbour County, Kansas; Cragin.

PART IV.—SPECIES OF NORTH AMERICAN ORTHOPTERA, DESCRIBED BY PROFESSOR LAWRENCE BRUNER, IN VARIOUS SHORT PAPERS FROM 1876 TO 1905.

ARPHIA ABERRANS.

Bruner in Caudell; *Proc. U. S. N. M.*, Vol. XXVIII, p. 467, 1905.

Described from a single female from the Huachuca Mountains, Arizona; Dr. R. E. Kunzé; Hebard Collection ex Bruner.

ENCOPTOLOPHUS PALLIDUS.

N. A. Fauna, No. 7, p. 266, 1893.

Based on an unstated number of specimens from one locality.

Single type here designated: ♂; Panamint Valley, California, April 6, 1891; Death Valley Expedition; U. S. N. M. Collection.

SCIRTETICA OCCIDENTALIS.

N. A. Fauna, No. 7, p. 267, 1893.

Described from a single female taken in the Argus Mountains, California, May, 1891; Death Valley Expedition; U. S. N. M. Collection.

TOMONOTUS FERRUGINOSUS.

Bruner in Caudell; *Proc. U. S. N. M.*, Vol. XXVIII, p. 470, Fig. 4, 1905.

Description based on an unstated number of specimens from six localities.

Single type here designated: ♂; Fort Grant, Arizona, [1882]; Hebard Collection ex Bruner.

TRIMEROTROPIS CÆRULEIPENNIS.

Can. Ent., Vol. XVII, p. 10, 1885.

Based on a series of both sexes from two localities.

Single type here designated: ♂; Umatilla, Washington, June 26, 1882; Hagen and Henshaw; U. S. N. M. Collection.

DRACOTETTIX PLUTONIUS.

N. A. Fauna, No. 7, p. 267, 1893.

Based on an unspecified number of males and females from two localities.

Single type here designated: ♂; Panamint Valley, California, April, 1891; Death Valley Expedition; U. S. N. M. Collection.

Pezotettix chenopodii.

Insect Life, Vol. VII, p. 41, 1894.

Based on large numbers of both sexes from a single locality.

Single type here designated: ♂; Grand Junction, Colorado, June, [1893]; Bruner; Hebard Collection ex Bruner.

Pezotettix hispidus.

Can. Ent., Vol. XVII, p. 12, 1885.

Based on an unstated series of both sexes from one locality.

Single type here designated: ♂; Colville, Washington, July 24, 1882; Hagen and Henshaw; Hebard Collection ex Bruner.

Melanoplus fluviatilis.

Ann. Rept. Nebr. Bd. Agr. for 1896, p. 136, fig. 34, 1897.

Based on an unstated series from one region.

Single type here designated: figured ♂; [Ashland, Nebraska, September, 1896]; Hebard Collection ex Bruner.

Pezotettix gracilis.

Can. Ent., Vol. VIII, p. 124, 1876.

Based on an unstated number of males and females from a single locality.

Single type here designated: ♂; Omaha, Nebraska, August-October; Hebard Collection ex Bruner.

Melanoplus herbaceus.

U. S. Dept. Agr., Div. Entom., Bull. 28, p. 25, Fig. 13b, 1893.

Based on a number of specimens of both sexes from one locality.

Single type here designated: figured ♂; El Paso, Texas, [November,] 1887; Bruner; Hebard Collection ex Bruner.

Pezotettix washingtonius.

Can. Ent., Vol. XVII, p. 14, 1885.

Described from a large series of both sexes from one locality.

Single type here designated: ♂; Loon Lake, Colville Valley, Washington, July 25, 1882; Hagen and Henshaw; Hebard Collection ex Bruner.

BRADYNOTES MONTANUS.

Can. Ent., Vol. XVII, p. 16, 1885.

Based on specimens of both sexes from two localities.

Single type here designated: ♂; Colville; Loon Lake, Washington, July 23–25, [1882]; Hagen; Hebard Collection ex Bruner.

CONOCEPHALUS ATLANTICUS.

Ent. News, Vol. X, p. 38, 1899.

Based on fourteen specimens of both sexes from four localities.

Single type here designated: ♂; Philadelphia Neck, Pennsylvania, [from] J. B. Smith; Hebard Collection ex Bruner.

CEUTHOPHILUS SILVESTRIS.

Bull. Washb. Coll., Vol. I, p. 127, 1885.

Described from eight specimens from a single locality.

Single type here designated: ♀; Topeka, Kansas, under logs in woods, F. W. Cragin; Hebard Collection ex Bruner.

MYRMECOPHILA OREGONENSIS.

Can. Ent., Vol. XVI, p. 43, 1884.

Based on a single female specimen from Portland, Oregon, summer of 1882; Henshaw; Mus. Comp. Zool. Cambr.

MYRMECOPHILA PERGANDEI.

Can. Ent., Vol. XVI, p. 42, 1884.

Described from an unstated series from the South Atlantic States.

Single type here designated: ♀; Washington, D. C., April 22, 1883, with *Camponotus pennsylvanicus;* Hebard Collection ex Bruner.

MARCH 5.

Because of preparations for holding sessions, March 19th, 20th and 21st, in commemoration of the founding of the Academy, no arrangement was made for the stated meeting on the first Tuesday of March.

CELEBRATION

OF THE

ONE HUNDREDTH ANNIVERSARY

OF THE

FOUNDING OF THE ACADEMY.

MARCH 19.

The President, the HON. SAMUEL GIBSON DIXON, M.D., LL.D., in the Chair.

Three hundred and eighty-two persons present, including delegates from American and foreign corresponding societies and institutions.

The President introduced the HON. RUDOLPH BLANKENBURG, the Mayor of Philadelphia, who welcomed the delegates and guests to the city.

After brief instructions from the Recording Secretary, the delegates responded to the names of the societies and institutions represented by them as they were called by the Corresponding Secretary, their letters and addresses being handed to the President.

After announcements by the Recording Secretary, the President read an Historical Address.[1]

The routine of a stated meeting was then proceeded with in the belief, as was explained by the President, that an illustration of the formula by means of which the Academy had transacted its business as a society for one hundred years would be of interest to those familiar with the results which made the present celebration worth while.

The minutes of the last meeting and the minute of the first Recording Secretary, Dr. Camillus Macmahon Mann, dated March 7, 1817, defining the foundation, were read.

Additions to the museum and library were announced.

The Corresponding Secretary reported on [illegible] in connection with the centenary [illegible].

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[1] The Mayor's Welcome, the President's Address and [illegible] the centenary will be published in [illegible] Commemorative volume [illegible] fifteenth of the [illegible]

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The Chair announced, with appreciative remarks, the death this morning of Thomas Harrison Montgomery, Jr., Ph.D.

The report of the Council was received.

The Publication Committee, acting in conjunction with the Centenary Sub-committee on Printing and Publication, reported that arrangements had been made for the publication of a Commemorative quarto volume (the fifteenth of the JOURNAL), an index to the entire series of the PROCEEDINGS and JOURNAL to the end of 1910, and a detailed history of the Academy by the Recording Secretary, of which the *Short History* published in connection with the *Philadelphia Founders' Week Celebration* may be considered a prodromus.

Papers under the following titles had been presented for publication since the last meeting of the Academy:

"Notes on a collection of fossils from Wilmington, North Carolina," by Amos P. Brown and H. A. Pilsbry (February 29).

"A synopsis of the genus Mastacembelus," by G. A. Boulenger (March 1).

"The vegetation of the banana holes of Florida," by John W. Harshberger (March 1).

"On the rate of growth of stony corals," by Thomas Wayland Vaughan (March 12).

"The faunal divisions of eastern North America in relation to vegetation," by Spencer Trotter (March 12).

"The relation of smell, taste, and the common chemical sense in vertebrates," by George Howard Parker (March 18).

"On the supposed Tertiary antarctic continent," by Sir William Thiselton Dyer (March 18).

Under the head of "Verbal Communications," the Recording Secretary gave some reminiscences of the people with whom he had been associated in the Academy for the past fifty years,[2] his first record of accessions to the library being dated February 4, 1862.

New nominations for membership were read. The election of members was postponed until next month.

The rough minutes having been read and approved, the meeting adjourned until the next morning at 10 o'clock.

SECOND DAY, MARCH 20.

The meeting was called to order by the President at 10.05 A. M.

The following communications were made:

[2] These notes, with many others of the same kind, will be found in Dr. Nolan's *History of the Academy*, to be published in connection with the Centenary Celebration.

EDWIN G. CONKLIN, PH.D.: "Experimental Studies in Nuclear and Cell Division." Illustrated.*

During several seasons extensive experiments were made on the segmenting eggs of *Crepidula plana*. These experiments include a study of the influence on nuclear and cell division of hypertonic and hypotonic sea water, of ether, alcohol, etc., of the lack of oxygen, of carbon dioxide, of the electric current, and of pressure and shaking. The following general conclusions may be drawn from this work:

1. Under the same treatment the effects on cell division may be extremely varied, owing, probably, to the different stages acted upon.

2. A dividing cell is much more easily disturbed or rendered abnormal than is a resting one; the mitotic figure in particular is very easily altered and most of the abnormalities observed arise from this source.

3. The earlier stages of cleavage are much more easily altered than are the later ones.

4. Certain general abnormalities occur after the most varied treatment, *e.g.*, the general result both of concentration and of dilution of sea water is to produce polyasters and to prevent the cleavage of the yolk.

5. On the whole, the results of the hypertonic solutions are the same whether they are produced by evaporation of the sea water or by addition of NaCl, MgCl, or KCl to sea water; in short, these salts exert no specific action on cell division.

6. The most general modification of the mitotic figure is the production of polyasters, multipolar spindles, and as a consequence, multiple nuclei. In many cases the cells are filled with asters and irregular mitotic figures during division, while in the resting stage they are filled with equally numerous resting centrosomes and nuclei.

7. The movements of the chromosomes are in many cases interrupted, so that they remain scattered along the spindle, while the cytoplasmic movements are frequently stopped or altered.

8. In some cases the achromatic portion of the nucleus is separated from the chromatic part, and the two may persist side by side during the resting stage of the cell; in the division stages the achromatic nuclei give rise to asters, the chromatic to chromosomes and both may divide indefinitely, giving rise to large numbers of chromatic and achromatic nuclei.

9. The most general modification of the division of the cell body is the suppression of the cleavage of the yolk; this occurs in practically all the experiments; at the same time the cleavage may proceed more or less regularly in the protoplasmic portion of the egg. In normal eggs the first and second cleavages divide the yolk into four equal cells (the macromeres) and from each of these three small cells (the micromeres) are budded off.

10. If the yolk remains undivided it gives rise in certain cases to three micromeres, which have the characteristics of those formed

* An asterisk after the title of the paper indicates that it is published in the Commemorative Volume of the JOURNAL of the Academy (XV).

from each of the four macromeres of the normal egg. If the yolk has divided once so as to form two macromeres, each of these may give rise to three micromeres, having the characteristics of the three quartet cells of the normal egg. In short, the number of micromeres depends upon the number of macromeres: when there are four of these as in normal eggs, the micromeres are formed in three quartets; when there are two, they are formed in three pairs; when there is but one macromere, *i.e.*, when the yolk remains undivided, the micromeres are formed singly.

11. When eggs are subjected to pressure the third cleavage which normally gives rise to the first group of micromeres, may divide one or more of the macromeres equally, thus giving rise to five, six, seven or eight macromeres. If the pressure is removed from such eggs each macromere gives rise to three micromeres in a manner approximately normal; again showing that the number of micromeres which may come from a macromere is fixed, whatever the number of micromeres may be.

12. The results stated in the two preceding paragraphs show that the omission or the addition of cleavages does not alter the character or localization of the egg substances and that the latter, when unimpeded, determines the character of the cell division.

13. Isolated blastomeres undergo partial development, each giving rise only to the cells which it would form if still a part of the entire egg, but the general form is entire, *i.e.*, there is no open side.

14. A weak electric current leads to the solution and disappearance of the chromatin and may destroy spindle fibres and astral rays, thus stopping mitosis. It may also destroy the polarity of the cell and prevent the normal separation of protoplasm and yolk.

15. Abnormalities of mitosis may perpetuate themselves in subsequent divisions, even when the cause which first induced them is removed.

CARLOTTA J. MAURY, PH.D.: "A Contribution to the Paleontology of Trinidad." Illustrated by drawings and charts.*

A large number of basal Eocene species recently discovered in the vicinity of Trinidad Island are described.

These fossils have a very significant bearing on the problem of the origin of the Midwayan and Lignitic faunas of the Gulf and of certain species found also in lower Eocene formations of the Atlantic coast of the southeastern States.

The shells were discovered by Mr. Arthur C. Veatch while exploring a small island called Soldado Rock. This lies off the southwestern end of Trinidad, in the Gulf of Paria, near the Serpent's Mouth, and rises about 100 feet above the surrounding waters. On this rock Mr. Veatch found a succession of eight beds of which Nos. 2, 6 and 8 were fossiliferous. The collections made by Mr. Veatch were given to the writer for identification.

Bed No. 2 was found to contain a rich fauna of basal Eocene forms, among the forty-four species being the exceedingly characteristic

North American species of that horizon, *Venericardia planicosta*, *Latirus tortilis*, *Calyptraphorus velatus*, var. *compressus*, *Levifusus pagoda*, and *Turritella mortoni*. To add to the interest, mingled with these were the characteristic Brazilian species from the Pernambuco beds, *Callista mcgrathiana*, *Chione paraensis*, and *Cucullæa harttii*. These had been previously found only in the Brazilian beds, especially in those of the Maria Farinha, a rivulet near Pernambuco. Thus the age of the Maria Farinha beds which before were usually doubtfully referred to the Cretaceous, and that of the Soldado No. 2 bed was definitely established as equivalent to the Eocene of Midway, Alabama.

The Soldado fauna was rich and varied. The genera *Ostrea*, *Venericardia*, *Fusus*, and *Turritella* led as regards numbers of species.

By the discovery of *Venericardia planicosta* at Soldado, its already remarkable range is extended south as far as 10° N. Lat. Moreover, its Antillean centre of distribution, postulated by Dr. Dall in 1903, is now established by the facts. In the light of those facts, we can trace this species from northern South America to southern and western North America and to northern and southern Europe.

From the Pernambuco basin the *Cucullæa harttii* fauna travelled north as far as Soldado; for in the early Tertiary there was no Amazon to act as a barrier with its discharge of fresh water. As far as known, Soldado was the northern limit of the migration of this fauna.

The *Venericardia planicosta* fauna travelled from the Soldado to the Alabama basin. This wandering species also crossed the strait covering the future Isthmus and established colonies along the Pacific coast in California and Oregon. It is a curious fact that its descendants are living there to the present day, although elsewhere the group has been entirely blotted out.

From the Alabama basin the *Venericardia planicosta* fauna continues to advance in a northeasterly direction up the coast, the peninsula of Florida having not yet been raised to force a detour. The accompanying species settled down along the way, *Turritella mortoni* advancing as far as Maryland. Thence *Venericardia planicosta* continued its advance alone to the north and east, eventually reaching the shores of northern Europe, probably *via* a Greenland-Iceland shallow water route. Established in Europe, it spread in great force over Belgium, France, and northern Italy.

In Bed No. 8, Soldado Rock, one of the commonest species is *Ostrea thirsæ*, so characteristic of the Lignitic Eocene of Alabama. Hence this species indicates a later migration from South to North America.

In conclusion, we may list the following as species which have migrated northward from the Soldado region as a centre of development: *Ostrea crenulimarginata* Gabb, *O. pulaskensis* Harris, *O. thirsæ* Gabb, *Modiola* cf. *alabamensis* Aldrich, *Venericardia alticostata* Con., *V. planicosta* Lam., *Meretrix* cf. *nuttaliopsis* Heilprin, *Lyria wilcoxiana* Aldrich var. *aldrichiana* n. var., *Levifusus pagoda*

Heilprin, *Clavella hubbardanus* ? Harris, *Latirus tortilis* Whitfield, *Fusoficula juvenis* Whitfield, *Calyptraphorus velatus* var. *compressus* Aldr., *Turritella humerosa* var. *elicitatoides* n. var., *Turritella nerinexa* Harris, *Turritella mortoni* Conrad, *Mesalia pumila* var. *allentonensis* Aldr., *Calyptræa aperta* Sol., *Natica* cf. *semilunata* Lea var., *Dentalium microstria* Heilprin. The same place of origin is indicated for the genera *Rimella* and *Venerupis*. The latter genus is now extinct in the Atlantic.

Interesting and ancestral forms of other genera, as *Pholas* and *Pleurotoma*, were also found at Soldado.

The Soldado faunas thus demonstrate that the Eocene of the Gulf coast, just like its recent molluscan fauna, contained a large Antillean element and that the lower Tertiary North American faunas were made up in great measure of immigrants from the shores of northeastern South America.

William J. Holland, Sc.D., LL.D.: "David Alter, the First Discoverer of Spectrum Analysis."

Dr. Holland called attention to the fact that five years before Kirchhoff, the celebrated German physicist, had announced the possibility of determining the various elements by Frauenhofer's lines in the spectrum, Dr. David Alter had published in the *American Journal of Science* the results of his observations upon the spectrum, showing the possibility of determining the presence through the spectrum of various metals and gases. Dr. Alter's communications had been extensively reproduced in foreign scientific journals at dates preceding the publication by Kirchhoff of his discovery.

Dr. Holland exhibited the prism made by Dr. Alter with which he had conducted his investigations.

John W. Harshberger, Ph.D.: "The Vegetation of the Banana Holes of Florida."

The eastern coast of Florida south of the sand hills at Delray is characterized by extensive outcrops of limestone known as Miami oolite. The surface of this Miami oolite weathers into angular nodules of lime rock and by water solution is eaten into pot holes of greater or less depth known as banana holes. These reach to the water table beneath the surface and have been filled with sand and organic débris until a soil has been formed which supports a vegetation distinct from that of the adjacent pine land. The soil of these sinks, which vary greatly in diameter, is more retentive of moisture than the porous soil of the pine land, so that the vegetation of broad-leaved trees and associated herbs is essentially mesophytic, while that of the pine land is essentially xerophytic. Most of the banana holes contain standing water during a part of the year.

The occupancy of these pot holes by the migration of plants into them is purely fortuitous, but the survival of any species, carried there by wind, water, and birds, is conditioned solely by the amount

of space, light, and edaphic relations. A very slight difference in the soil, drainage, depth below the general surface of the adjoining pine land, amount of soil or standing water, amount of light which penetrates through the close stand of surrounding pine trees, makes a difference in the vegetation that fills the different banana holes.

In all, twenty-three plants were found in seventeen different banana holes investigated in a region where they are common, namely, between Naranja and Princeton in South Florida. The following is a list of the species and their relative abundance: *Sabal palmetto* (12), *Anona glabra* (11), *Chrysobalanus pellocarpus* (8), *Sagittaria lancifolia* (8), *Myrica cerifera* (6), *Persea pubescens* (4), *Vitis munsoniana* (4), *Proserpinaca platycarpa* (4), *Cladium effusum* (4), *Ilex cassine* (3), *Cephalanthus occidentalis* (3), *Salix longipes* (3), *Phlebodium aureum* (2), *Isnardia natans* (2), *Polypodium polypodioides* (1), *Typha latifolia* (1), *Phragmites phragmites* (1), *Smilax laurifolia* (1), *Quercus virginiana* (1), *Metopium metopium* (1), *Morinda roioc* (1), *Conoclinum dichotomum* (1), *Willugbaeya scandens* (1). Of these species nine are trees; two, shrubs; three are lianes; several are epiphytes; four are rooting aquatics and two are submerged aquatics.

The origin of these banana holes and the character of the native vegetation with which they are filled suggest the origin and nature of the larger areas of deciduous subtropic and tropic forest trees known in the South as hammocks. As the banana holes exist in all sizes from those which are a meter in diameter to those which cover several hectares, no sharp distinction can be made between the vegetation of the larger banana holes and the smaller hammocks which occur in the same region. Presumably the hammocks have had a similar origin as the banana holes by starting in a shallow, basin-shaped hollow of the prevailing oolitic limestone. This hollow has filled gradually with leaf-mold and sand liberated by the solution of the surrounding lime rock of which sand is a constituent until a sandy loam soil is formed in which the tropic forest trees find suitable conditions for growth. Once the hammock vegetation has established itself, it becomes self-perpetuative and forms a climax forest, which becomes an exclusive type gradually encroaching upon the area of country occupied by the slash pine, *Pinus caribaea*, which with its associates forms an ancient and successful type of forest holding well its own against other competing types of vegetation.

FREDERICK W. TRUE, LL.D.: "A New Species of Delphinodon." Illustrated.*

Dr. Frederick W. True gave an account of a new species of fossil porpoise from the Miocene formation of Maryland, belonging to the genus *Delphinodon*, for which the name of *Delphinodon dividum* is proposed. The U. S. National Museum was engaged in 1908 and 1909 in making collections of cetacean remains from the Calvert Cliffs, Maryland, and obtained several skulls and fragments of skulls, many limb bones, and large numbers of vertebræ. In

addition, the Museum obtained a nearly complete skeleton of a fossil porpoise belonging to the family Delphinidæ. This specimen comprises the skull and mandible, about thirty vertebræ, many pairs of ribs, a scapula, limb-bones, and numerous teeth, including several *in situ*. It is possible from this material to determine accurately the characters of the species. The skull is distinctly delphinoid, but the crowns of the posterior teeth, instead of being simple and conical, as in typical recent Delphinidæ, are trituberculate, with rugose enamel. The cervical vertebræ are all separate, the neural spines of the thoracic vertebræ erect, the transverse processes of the lumbar vertebræ long and slender, but not acuminate, and the ulna furnished with a lunate olecranon.

The new species appears to belong to the genus *Delphinodon*, which is based on two or three forms known only from detached teeth, and hitherto regarded as belonging to the Squalodontidæ. From the evidence furnished by the new material, the genus should probably be transferred to the Delphinidæ.

HENRY H. DONALDSON, PH.D.: "The History and Zoological Position of the Albino Rat."[2]

There are two common rats in the United States: *Mus rattus*, the black rat, together with *Mus rattus alexandrinus*—its gray variety—and *Mus norvegicus*, the common brown or Norway rat. *Mus rattus* entered Europe from the east about the thirteenth century and spread widely, reaching America on the ships of the early explorers and colonists. *Mus norvegicus*, also coming from the East, did not arrive in Europe until the beginning of the eighteenth century and in America not until 1750 or 1775. Wherever the Norway rat has gone it has displaced the *Mus rattus*. The common albino which we see to-day is a strain of the Norway rat. It seems probable that at one time albinos of *Mus rattus* must have existed, but they are nowhere to be found at present. The origin and history of the existing albinos is obscure, but there is no evidence that they have established themselves in open competition with the pigmented forms.

They are always found under conditions of domestication. This manner of life has led to some structural modifications, and especially noticeable is the diminution in the weight of the central nervous system.

Although all albinos breed true to color, yet their composition is not identical, as is shown by the fact that in crosses of extracted albinos with pigmented forms, the color markings of the progeny are modified according to the ancestry of the albino. A pure strain of albinos is therefore not obtainable.

EDWARD B. MEIGS, M.D., and L. A. RYAN, PH.D.: "The Ash of Smooth Muscle."[3]

The smooth muscle of the bull-frog's stomach has been analyzed quantitatively for potassium, sodium, iron, calcium, magnesium,

[3] The entire article in *The Journal of Biological Chemistry*, May, 1912.

phosphorus, chlorine, and sulphur by methods in general similar to those described by Katz in the *Archiv für die gesammte Physiologie*, 1896, Vol. LXIII, pp. 1 *et seq.* At least two determinations were made in the case of every element; and in no case, except that of sodium, did the parallel determinations differ from each other by more than 15 per cent. In the case of sodium, one determination was about 24 per cent. higher than the other. The following are the average amounts of the elements found, given as per cent. of the fresh tissue: Potassium, 0.3250; Sodium, 0.0726; Iron, 0.0007; Calcium, 0.0042; Magnesium, 0.0129; Phosphorus, 0.1372; Chlorine, 0.1195; Sulphur, 0.1612. Six determinations were made of the water and total solids. The averages were solids, 17.70 per cent.; water, 82.30 per cent. The widest differences were solids I, 17.39 per cent.; solids VI, 17.99 per cent.

Parallel analyses of the ash of the striated muscle of the same frogs were made, and the results obtained were quite close to those reported by Katz for frog's striated muscle. The work indicates that smooth muscle contains somewhat less potassium and phosphorus and considerably more sodium and chlorine than striated muscle, but the differences are much less marked than has sometimes been supposed.

The chemical work was supplemented with microscopic study of fixed and fresh samples of the tissue analyzed as "smooth muscle," and it was found that about 80 per cent. of its volume was smooth muscle fibre; about 5 per cent. extraneous connective tissue; and the remainder, interstitial spaces between the muscle fibres.

Marshall A. Howe, Ph.D.: "Reef-building and Land-forming Seaweeds." Beautifully illustrated.

That the corals and other lime-secreting animals are active agents in building reefs and forming land has been a matter of common knowledge and belief for more than half a century, but that certain marine algæ or seaweeds also have an important and sometimes predominating part in the same great work has received no particular emphasis until quite recent years. Most people think of sea plants, if they think of them at all, as small delicate ornamental "sea-mosses" or as coarse, succulent, not especially attractive, kelps or rockweeds, having in either case, little solid substance to be left behind on their decay. The fact is, however, that there are many different kinds of marine plants that secrete lime from the sea water and are more or less hard and stone-like, so that their decay or their continued upward growth is accompanied by a considerable increase in the height of the sea bottom wherever these plants happen to be growing. The corals are, generally speaking, confined to the warmer seas, but the corallines, lime-secreting marine plants with a superficial resemblance to the corals, are more widely distributed, having, in fact, been found to be very abundant more than 12° north of the Arctic Circle. The late Professor Kjellman, of Upsala, has stated that off the shores of Spitzbergen and Nova Zembla a certain coral-

line (*Lithothamnium glaciale*) forms thick layers on the ocean floor, mostly in 60 to 120 feet of water and that "in the formation of the future strata of the earth's crust in these regions it must become of essential importance." Dr. Henry B. Bigelow, of Harvard University, was quoted as stating that "algæ probably form the greatest mass" of the "shell sands" of Bermuda, and Sir John Murray, in reporting the results of the famous Challenger Expedition, has recorded his opinion that in three out of four analyzed samples of so-called coral sand or mud from Bermuda the calcareous seaweeds and their broken-down parts composed over 50 per cent. of the mass. As Dr. Bigelow has remarked, the reports of the borings in Funafuti, a "true coral" island of the Ellice group, recently published by the Royal Society of London, are of special interest in this connection. Borings were here made to a depth of over 1,100 feet and the materials brought up indicate that the lime-secreting seaweeds have been of greater importance then the corals in the formation of this island.

The lecture was illustrated by about forty lantern-slides, showing various types of calcareous seaweeds, and also by specimens from the speaker's collections in the West Indies and elsewhere.

Adjournment for luncheon.

The meeting reconvened at 2.40 P.M., when the following communications were made:

BENJAMIN SMITH LYMAN: "Natural History Morality."

Our predecessors, in founding the Academy, a hundred years ago, probably little dreamed of any direct association of morality with the study of natural history. They had doubtless been attracted to the study by the beauty of its objects, as well, perhaps, as by an instinctive feeling that a more thorough knowledge of them might lead, not only to various commercial benefit, but to intellectual broadening and improvement in many ways. Naturally, the first thing to be done was to collect the facts, to describe and distinguish by names the countless varieties of animals and plants; and then to arrange them in systematic order. Whether the expression "natural sciences" in the Academy's name was merely intended to cover natural history or not, it certainly has turned out that, for a hundred years, that has been almost exclusively the Academy's field of work. Only through occasional strict construction and a literal, logical interpretation of the society's name have astronomy, chemistry, and other branches of physics been able, from time to time, to assert and maintain a scanty foothold in the Academy's proceedings. Through almost the whole of the first half of the century, the natural history work was patiently, zealously, creditably, and interestingly occupied with collecting, describing, naming and systematizing the natural forms that could be found in near and distant parts of the world. Since then, Darwin's great discovery of the origin of species through natural selection, so sympathetically

appreciated at once by our Academy, has immensely enlarged the scope and interest of the study, making it plain that all living species, including man himself, have originated one from another; so that all are but genetically consanguineous parts of one great whole, and the study of one part is, therefore, more distinctly and surely a guide to the complete understanding of the other so related, and thereby more or less similar, parts. From a full consideration of this relationship may be deduced the strongest possible incentive to morality and the clearest guide to its correct principles.

We may perceive that natural history studies teach us that what is aimed at is not the benefit and survival of each and every individual, but the perpetuation and progress of the race, through the success of its most vigorous, ablest, fittest, members. For, in fact, not only are species derived from one another, so as to be but parts of one whole; but a race is yet more closely a unit, the somewhat varied outgrowth of a single progenitor, as the leaves and limbs of a tree grow out from one stem; though, in some cases, detached, to be sure, like the rooted limbs of a banyan tree separated from the perhaps perished parent trunk, or the rooted runners of a strawberry-plant, or of a walking-fern, or of any layered plant. The propagation by artificial grafting of a bud, or scion, on a kindred stock is closely parallel, with some variation in character from the new stock. The perpetuation by a seed, a specialized portion of the tree, with the whole character of the tree concentrated in small compass, as fully as in a bud or scion, and naturally detachable and capable of growing in a favorable soil and temperature, is plainly no less an outgrowth, a growing forward, of the parent tree, than is the growth of a rooted limb, or runner, or a grafted bud or scion. In the case of animals, the simplest forms, like the amœba, merely divide in halves, and each half grows forward, with equal claim to be the identical parent stock; but, in more complex organisms, minute specialized portions only of two parents, with the character of these parents concentrated therein (as a plant's is in its seed), unite and grow, when favorably situated, partaking of both characters, as a scion grafted on a rooted stock is doubly affected. The race, then, is the perpetuated individual, and all parts of the race are, in some sort, one, identical, with its progenitor; and as all races and species have been derived from one another, the oneness, or identity, extends to all living beings.

Surely, this identity is the highest incentive, as well as the best guide, to morality. In the first place, it is seen that the true object of morality is the benefit of the race, rather than of the individual; though, of course, the individuals partake of the benefit. This view makes the individual willing to die, if need be, for the true benefit of his race. The appropriate instinct established by natural selection makes the mother, whether human or brute, fight with the utmost courage or most ingenious cunning for the preservation of her young, as, indeed, for her own perpetuation, for the life of what has been a part of her own body, and is still no less a part of her, notwithstanding its being detached.

Here, too, is the root of the more kindly features of the morality taught by natural history, that fully counterbalance what may often be thought the dominant and essential, but harsher, characteristics of the instinctively selfish, sometimes fierce, struggle for existence under natural selection, wholly incapable, it may seem, of any connection with the gentle moral rules of conduct for men's intercourse with men, which are now generally supposed to require mild self-abnegation. To some degree among many of the lower animals, but still much more in the human race, the weak and defenceless young need for a time the protection and aid of the parents. Any portion of the race that should have been deficient in the instinct that provides such help would obviously have died out; so that the instinct has become universal. This instinct, not only unites in friendliness the parent and child, but tends to soften the character of both, even with regard to outsiders, and makes possible and probable more or less friendly intercourse between brethren, and, by a sort of natural infection, between less closely related men; and it is this feeling that has been at the bottom of all systems of morality.

The aim, in general, is not to favor one individual only, but to give all an equal chance, to establish justice, in order to enable the ablest, the fittest, to survive and perpetuate the race in the highest vigor and best condition; while the weaklings and those possessed of characters prejudicial to the healthful permanence of the race shall tend to die out and disappear. Clearly, the success of the race depends on the success of the fittest individuals in this struggle for existence and justice. "A mush of concession," in which the individual always yields everything, with a total eradication of seeking for selfish advantage, would be as harmful to the prosperity and eventual survival of the race, as would be an over-grasping selfishness that would deny what is fair to every competitor. The race can only progress through the benefit to individuals. Selfishness, then, the desire for private gain, is not altogether wrong, but should be enlightened, should avoid running to excess, by conceding, not only justice, but (to insure against the possible exaggeration of one's own ideas of what might be rightfully claimed) should yield something more than what, to the claimant, seems mere justice; that is, should aim at nothing more than justice seasoned with kindness. This, then, is the practical rule that natural history indicates for the guidance of intercourse between men; and enforces it unswervingly, impartially, and inexorably by the most effectual penalties for any transgression, even to the shortening of life, or to the wretchedness of a later generation, or the extermination of a family or tribe, with as much certainty as the punishment for the violation of hygienic laws.

The incentive to high morality is particularly obvious to anyone who realizes that his child is but an outgrowth from himself, that it is, in fact, a part of himself. For he would perceive how important it is that in this new life he should inherit the best possible charac-

teristics from both himself and the child's mother, and should, thereby, be able to start forward on his new career under the most favorable physical and moral circumstances. The idea greatly reënforces the natural instinct, sometimes dulled, or even wholly perverted, towards family life, which has long been considered the chief promoter, if not the very foundation, of morality.

Evidently, natural history supplies the clearest principles and most cogent motives for morality; and further and more precise knowledge of the instinct of animals in their natural state (not so much in the artificial, pampered, domesticated condition) may sometimes yield important guidance towards detailed rules of conduct. Special applications of the principles (not according to mere speculations, but to observed facts) are to be worked out, also, by courts of justice, aided by schools, colleges and learned societies, as the tendency has been for hundreds of years, especially among the more logical nations.

Natural history, then, teaches through the thorough unity and consanguinity of all living things, that, besides sympathizing with them all and perceiving how much may be advantageously learned from them as our relatives and congeners, we must not merely struggle with them and with each other for existence and the survival of the fittest, to the benefit of the race, but for the same reason, equally must aid in the protection of our weak immature ones, strictly our second selves, and by this habit, or instinct, maintain complete morality, under the strongest incentives, unerringly and inflexibly guided by natural selection.

JACQUES LOEB, M.D., PH.D., Sc.D.: "Experiments on Adaptation to High Temperatures." (No abstract.)

HENRY SKINNER, M.D., Sc.D.: "Mimicry in Butterflies."*

It has been stated that some of the females of the American species of *Papilio* have gradually changed their appearance to resemble *Papilio philenor*, a species which in the larval stage feeds on *Aristolochia serpentaria*, a plant having a root poisonous to man. It is therefore contended that in the imago stage this butterfly is nauseous or poisonous to birds, and that the birds, mistaking the edible species for *philenor*, avoid them.

The objections to this hypothesis are, that the records of birds eating butterflies are very meagre, and there is no evidence to prove that *philenor* is nauseous or poisonous to birds.

It has been shown that plants may be poisonous to man, to some other animals, and yet may be eaten by birds with impunity.

The species said to be protected by their resemblance to *Papilio philenor* are different in appearance in the two sexes and it is the females that show this mimicry. These sexual differences are termed antigeny and it is not unusual in the butterflies. It is due to some general law and not in certain instances to so-called mimicry.

The evidence advanced to prove mimicry in the Papilios was considered inconclusive. Other cases of so-called mimicry in the butterflies were regarded as being brought about by environmental conditions, such as vertical distribution and desert distribution.

SPENCER TROTTER, M.D.: "The Faunal Divisions of Eastern North America in Relation to Vegetation."*

Vegetation is more directly concerned in the problem of faunal distribution than are the factors of heat and moisture. These, of course, control vegetation, but soil is a more important control factor. Topography likewise exerts a considerable influence. Zonal arrangement of faunas is unnatural. On this basis of the vegetation control, the following outline of Faunal Areas is submitted as best expressing the known facts:

I. THE SUB-ARCTIC FAUNA.
(a) Barren Ground Type.
(b) Tree-limit Type.
II. THE ATLANTIC FOREST FAUNA.
(a) Coniferous Forest Type.
(b) Deciduous Forest Type.
III. THE COASTAL PLAIN FAUNA.
(a) The Alluvial Forest Type.
(b) The Marshland Type.
(c) The Pine Barren Type.
IV. THE GRASSLAND FAUNA.
(a) The Prairie Type.
(b) The Steppe Type.
V. THE PLATEAU FAUNA.
(a) The Cactus Desert Type.
(b) The Mountain Forest Type.

T. WAYLAND VAUGHAN, PH.D.: "Rate of Growth of Stony Corals." Illustrated. (No abstract.)

HENRY A. PILSBRY, PH.D.: "On the Tropical Element in the Molluscan Fauna of Florida."*

A sketch of the successive non-marine faunas of the region was given and the genesis of the several elements composing the molluscan fauna was traced. A Mexican group of forms was recognized and evidence was adduced to show that they entered southern Florida at the close of Miocene or very early in Pliocene time. Antillean species were held to be of later advent in Florida. The probability that they had been carried from Cuba by hurricanes was discussed. The various points were illustrated by lantern slides of shells and maps.

The session closed with a beautifully illustrated communication on "The Photography of Wild Birds," by WILLIAM L. BAILY. (No abstract.)

Adjournment until the following morning.

A brilliant invitation reception was given in the evening by Dr. Dixon, Mrs. Dixon, and Miss Dixon in the Bellevue-Stratford Hotel from 8 until 11 o'clock.

THIRD DAY, MARCH 21.

The meeting was called to order by the President at 10.30 A.M.

The Chair referred to the fact that the late Dr. Montgomery had been placed on the program for the first paper of the session under the title "Human Spermatogenesis: Spermatocytes and Spermiogenesis," but his funeral would take place to-morrow at 10.30 A.M.

EDWIN J. HOUSTON, PH.D., then made a communication on "How the Natural Sciences can be made Attractive to the Young."

If the natural sciences fail to interest the young, the fault is due neither to the character of the subject nor the age of those whom we wish to instruct, but to some faulty or illogical method of presentation. The collections of the Academy present a fine opportunity to interest the young in the natural sciences and they are doing this now, but more could be done. The Academy encouraged and assisted such men as Leidy, Cope, Morton, Rand, Tryon, Ryder, Cassin, Parker, and many more, but it may have failed to develop others.

It is one thing to read about a natural object and another to examine a carefully prepared specimen of it, still better to know it by actually touching and handling it. The young should be encouraged to make collections for themselves. In order to insure the best results, the aid of a teacher will be required. Lectures specially arranged are a great help, and means should be taken to encourage exchange, an endeavor being made to promote what may be called chumminess among the collectors. Interest will soon die if the young investigator has no companion.

Suitable books are essential. They are not numerous. The average books on the natural sciences cannot be used by children. Dr. Houston had prepared a series of books, keeping in mind the unwillingness of the child to read anything that looks like a schoolbook. He had adopted the style of the Jules Verne stories and endeavored to improve on it, making the work interesting while being scrupulously careful to sacrifice no scientific truth. The plan of these books was described in detail.

The following communications were also made:

JAMES A. G. REHN: "The Orthopteran Inhabitants of the Sonoran Creosote Bush, Covillea tridentata."

The species of Orthoptera known to occur only on this bush were shown to be six in number, representing three families and five genera of the order. The remarkable color resemblance of certain

of the forms to portions of the plant was discussed and the distribution of the species within the range of *Covillea* stated. Certain other species of the order very commonly found on the same shrub were also mentioned. Specimens of the host plant of all the peculiar species and a map of the distribution of the creosote bush were exhibited.

HENRY FAIRFIELD OSBORN, D.Sc., LL.D.: "Tetraplasy, a Law of the Four Inseparable Factors of Evolution."*

Upwards of twelve years of work on the group of fossil mammals first made known by Joseph Leidy, which may now be known popularly as the Titanotheres, had led to the conviction that vertebrate palæontology may concern itself with two great questions in evolution:

(1) The origin of new characters.
(2) The transformation of existing characters.

Excluding any external agencies, we must seek such *origins* and *transformations* either in:

(1) Environment, physical or biotic.
(2) Ontogeny, that is, in the development of the body, or soma.
(3) Heredity, or in the development of the germ.
(4) Selection, or in the competition between organisms.

Having reached in 1905 the conclusion that our quest for the origin and transformation of characters must be directed to one or the other of these four factors, working individually or separately, the author published in 1908 what he believes to be the most fundamental biological law, and termed it *The Law of the Four Inseparable Factors*.[4]

In nature each of these factors is in a sense independent, with its peculiar or intrinsic phenomena; in another sense dependent, or intimately related to each of the other factors.

It is a striking fact in the history of biology, from the middle of the 18th century, that the particular factor upon which naturalists have concentrated their attention has seemed to them the all-important or all-sufficient factor. Thus Environment in the minds of Buffon, or Semper, or Wagner appeared to be the efficient cause of evolution. Similarly, Ontogeny in the minds of Lamarck, Spencer, Cope, seemed to be the primary source of evolutionary change. Again, Selection in the minds of Darwin and Wallace, combined with hereditary fortuitous variation, seemed to possess the chief constructive power in evolution. Finally, as the latest phase, Heredity, as developed by Galton, Weismann, Mendel, De Vries, and Bateson, has come to be regarded as the chief centre of transformation.

[4] "The Four Inseparable Factors of Evolution, Theory of their Distinct and Combined Action in the Transformation of the Titanotheres, an Extinct Family of Hoofed Animals in the Order Perissodactyla." *Science*, N. S., Vol. XXVII, No. 682, Jan. 24, 1908, pp. 148–150.

The interoperation of the four factors may be represented symbolically by the letters E. O. H. S.

Returning to our original questions as to: (1) the origin and (2) the transformation of characters, we first observe that there is the following general relation:

External	Initiation	Environment,	E.
Internal	Genesis	Ontogeny,	O.
"	"	Heredity,	H.
External	Fixation	Selection,	S.

All phenomena involving either the origins or the transformations of character may be conveniently represented by the use of formula composed of E, O, H, S. Similarly, all interpretations of changes of character should be made with this interoperation of the factors in mind. For example, in the matter of continuity or discontinuity, we find that E, O, H, S, must all be considered. Thus the "continuity in Heredity" of the germ plasm is no more vital than the "continuity in Ontogeny," or "continuity in Environment," or "continuity in Selection," because change or discontinuity in any one of these three latter factors, E, O, S, immediately or finally results in transformation of character in H.

Again, in experimental as contrasted with natural conditions we observe the following:

In experiment,

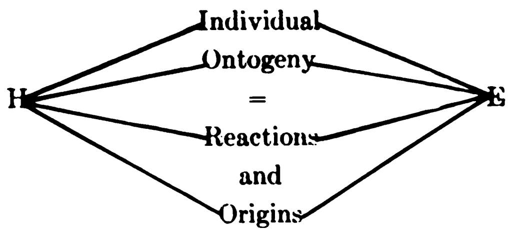
Selection may be removed or altered.
Environment may be altered.
Ontogeny may be altered.
Heredity may be affected through E, O, S.

On the contrary, in nature,

E, O, H, S, are constantly interoperative.

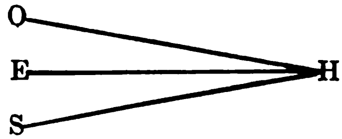
Thus the tetraplasic law, first conceived in 1905, first expressed in 1908, may now be expressed in 1912 as follows: *The life and evolution of organisms continuously centre around the processes which we term Heredity, Ontogeny, Environment, and Selection; these have been inseparable and interacting from the beginning; a change introduced or initiated through any one of these factors finally results in a genetic change.*

The conception of the individual, therefore, may be expressed in the following diagram A:



That is, the Ontogeny of the individual springs from its Heredity, with its incessant reactions and origins, in response to its Environment.

Similarly, Heredity is sooner or later in the history of a phylum under the influence of the three factors, Ontogeny, Environment, Selection, as represented in diagram B.



This conception of the continuous interoperation of the four factors in no way diminishes Heredity as the final seat of all genetic change; either from the first or as a sequel to a long series of antecedent interoperations, the seat of the *origins* and of the *transformations* of characters is certainly in Heredity.

Thus so far as the present law is concerned, the problem of evolution is to determine the relation between the interoperation of the four factors E, O, H, S, and the final fixation of the results of this operation in Heredity.

Merkel H. Jacobs, Ph.D.: "Physiological Characters of Species."

In the experiments, on which the paper was based, an attempt was made to compare a number of organisms with regard to certain of their physiological characters. The organisms selected were twelve species of protozoa, viz., *Paramecium caudatum*, *P. aurelia*, *P. bursaria*, *Colpidium colpoda*, *Coleps hirtus*, *Blepharisma lateritia*, *Euplotes patella*, *Vorticella nebulifera*, *Peranema trichophorum*, *Euglena viridis*, *Chilomonas paramecium*, and *Entosiphon sulcatum*. The character chiefly studied was the effect of carbon dioxide on the movements and the general vitality of these forms.

The experiments showed that each of the species in question reacts to carbon dioxide in a characteristic manner and that each has a general resistance to its toxic effects, which while varying to some extent with different individuals and in different cultures, is nevertheless fairly constant for the species. The most sensitive form studied was found to be *Coleps hirtus*, which is killed, as a rule, in three or four minutes, while *Colpidium colpoda*, the most resistant form, under exactly the same conditions, remains uninjured after many hours. Some forms were killed outright very quickly, while others, although losing all power of movement within a few moments, yet retained for a long time the ability to recover when again restored to normal conditions.

One of the most striking results obtained was the demonstration of the difference in the effects of carbon dioxide on different elements within same cell. In general, contractile structures (myonemes) are paralyzed within a few seconds, while vibratile structures (cilia,

membranelles, flagella) are affected only after a much longer time. In *Vorticella*, for example, the power of contraction is lost in less than a minute, while the membranelles may beat normally for three-quarters of an hour or longer. Sometimes a converse relation in the effect of carbon dioxide on these two classes of structures appears, the contractile elements being first stimulated and then paralyzed and the vibratile ones often temporarily stopped and then started again.

GEORGE HOWARD PARKER, Sc.D.: "Sensory Appropriation, as illustrated by the Organs of Taste in Vertebrates."*

In addition to smell and taste, ordinarily regarded as chemical senses, vertebrates possess a third sense which may be called the common chemical sense and which is exemplified in man in the sensitiveness of the mucous surfaces of the eye, nose, etc. Contrary to the opinion of Weber, solutions of odorous substances introduced into the human nose can be smelled. Hence Nagel's contention that the nose of the water-inhabiting vertebrates is an organ of taste rather than an organ of smell is unfounded and the recent work of Parker and of Sheldon has shown conclusively that fishes scent their food with the nose as air-inhabiting vertebrates do, *i.e.*, the nose in vertebrates, water-inhabiting as well as air-inhabiting, is a distance receptor. A comparison of the chemical responses of catfishes, with and without organs of taste, shows that the common chemical sense is more closely related to the sense of taste than to the sense of smell and that its receptors are the free-nerve terminations of certain fibres in the spinal and cranial nerves. Of the three senses, smell, taste, and the common chemical sense, the most primitive is the sense of smell, which probably represents the specialized and restricted remains of a general chemical sense common to the whole surface of the invertebrate ancestor of the vertebrates. By a central migration of the cell body of these primitive olfactory receptors of the general surface, the organs of the common chemical sense were produced. These in turn appropriated groups of epidermal cells which in time became specialized into taste buds, and thus arose the third and last of these chemical sense organs, the organs of taste.

JOHN M. MACFARLANE, PH.D.: "The Relation of Protoplasm to its Environment."*

The simplest plants now living are the Schizophyceæ and the Schizomycetes, both composed of cells or cell chains with rich granular protoplasm, with or without a chromatophore, and either devoid of a nucleus or with a granular chromatin rudiment of it.

The species of the two groups now found in hot springs at temperatures of 55°–75° C. are probably primitive types, alike on account of their wide distribution over the world and their adaptation to high temperatures. From these, there seem to have developed

forms that became acclimatized to cooler conditions, though the thermophilic bacteria of soils, manure heaps, etc., still grow and multiply at a high temperature and may be direct descendants of hot spring species.

The spores and even at times the mature plants of some fungi, mosses, ferns and selaginellas can resist prolonged exposure to 55°–70° C. without injury, while 100° C. may not destroy the vitality of the spores. Experiment has equally shown that spores, or cells, of some of the above can be exposed to from 75° C. to —150° C. without loss of germinating capacity. Amongst flowering plants, seeds have been exposed to from —75° C. down to —200° C. without injury, while many species of tropical desert regions and of sub-arctic or arctic regions show a range of temperature resistance from 75° C. down to —65° C. An abundant protoplasm and stored food, enclosed by thick mucilaginous or cuticular walls that can act as regulators to environal changes, are all-important cell factors in ensuring continued protoplasmic existence. The relative water content of the cell, and the composition of the protein substances that are included, are probably the main factors in limiting protoplasmic resistance.

William H. Dall, A.M., Sc.D.: Mollusk-fauna of Northwest America.* (No abstract.)

The meeting adjourned at 1 P.M. for luncheon, and was called to order again by the President at 2.20 P.M.

Henry G. Bryant: "Government Agencies in the Advancement of Geographical Knowledge in the United States." Illustrated by maps and charts.

Attention was drawn to the importance of agencies such as the U. S. Coast and Geodetic Survey and the Geological Survey in advancing geographical knowledge. While the picturesque aspect of the subject represented by expeditions of exploration has received attention, the quiet work of these organized forces of the government is little known to the general public. In early days, the Federal Government sent Lewis and Clark, Pike and Fremont to investigate the western country. The work of these men and the discovery of gold in California resulted in bringing about a fair knowledge of the main physical features of the country by the middle of the nineteenth century.

The Coast Survey is the oldest bureau of applied science, and for nearly a century has been engaged in surveying the coasts of the United States. Its officials, co-operating with those of Canada, are surveying the Alaska boundary, where conditions of unusual hardship are encountered. The operations of this bureau have included: A survey of the coast, deep-sea soundings, study of the tides and of the Gulf Stream, and of terrestrial magnetism.

Following the close of the Civil War and the rush of settlers to the West, there came an imperative demand for a better knowledge of the western country, which resulted in the organization of the U. S. Geological Survey in 1879. The geographical work of the Survey—as illustrated by excellent topographical maps on various scales, and our contribution to the great International Map of the World—was referred to.

The availability of all this material at a nominal cost has done much to advance geographical knowledge. Other official agencies which assisted were: The General Land Office, which issues numerous maps; the Hydrographic Office of the Navy Department, which publishes charts of foreign coasts and harbors, and the Map Collection of the Library of Congress at Washington, which was described as the largest in this country.

WITMER STONE, A.M.: "Fauna and Flora of the New Jersey Pine Barrens." Illustrated by beautiful lantern pictures.

Leisure time during the past fifteen years had been occupied in collecting data upon the distribution of animal and plant life in the coastal plain of New Jersey. There was a marked difference in the fauna and flora of western and central New Jersey south of the fall line, as compared with the Pine Barren area, and east of the latter there existed a narrow strip bordering the maritime marshes and recurring on the coast island, which possessed the same type of plant and animal life as characterized west Jersey. The Cape May peninsula belonged also mainly to this region, the Pine Barren elements being only local.

The historic associations of the Pine Barrens were considered, and the plants discovered there by Bartram, Pursh, Rafinesque and Nuttall were enumerated. In considering the change of conditions in the region, stress was laid upon the constant increase in the extent of cultivated cranberry bogs and the injurious effect of the winter flooding upon various rare plants which inhabit the native bogs. *Abama americana*, and *Tofieldia racemosa* were two species which were seriously threatened in this way. Mr. Gifford Pinchot's theory in regard to the origin of the stunted forest of the elevated region known as the plains was endorsed. No difference could be detected in the character of the soil of this region and other parts of the Pine Barrens except in the greater coarseness of the sand and gravel, and repeated forest fires seemed to have kept down the tree growth when once the stunted condition had been produced.

Numerous lantern slides illustrating the scenery and characteristic birds and plants were exhibited showing the transition experienced in crossing the coastal plain from Philadelphia to the coast.

In the evening one hundred and sixty members, delegates, and guests partook of an enjoyable banquet in the remodelled library hall. Dr. Conklin acted as toastmaster and responses were made

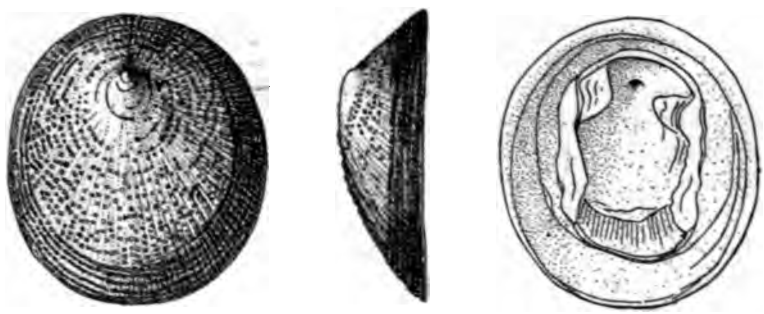
by His Honor the Mayor; Mons. de Pulligny, the Director of the French Commission of Engineers to the United States; Dr. Henry Fairfield Osborn, of the American Museum of Natural History; the President of the Academy; Dr. Theodore Gill, of the United States National Museum; Dr. William J. Holland, of the Carnegie Museum, Pittsburg; and Dr. Nolan. The celebration of the one hundredth birthday of the Academy terminated with the singing of *Auld Lang Syne*.

The following were ordered to be published:

PHENACOLEPAS MALONEI n. sp.

BY E. G. VANATTA.

Shell white, suborbicular. Apex moderately elevated, slightly recurved, situated at the posterior fourth and to the right of the median line. About 2 mm. from the smooth apex, fine raised radial striæ begin and increase in number to the margin where they number about 150. The surface is covered with irregular concentric rows of grains which become more regular near the margin, where they form about 5 beaded costæ completely encircling the shell. There are 11 concentric lines of tubercles upon the posterior slope, 16 upon the right side, 22 upon the anterior slope and 17 upon the left side. The posterior slope is nearly straight and slightly concave near the apex, anterior slope convex, base slightly arcuate. Margin



1 2 3

not crenulate. Interior with a slight pit under the apex; muscle scar in the form of an irregular horseshoe, open in front, at which point about 20 of the radial striæ may be seen through the shell.

Alt. 4.5, diam. 13.5, length 15 mm.

In ballast from Santa Rosalia, L. California, collected by Mr. J. G. Malone. Type No. 105,741 in the collection of the Academy of Natural Sciences of Philadelphia.

This shell differs from *granulosa* Thiele by having the apex nearer the posterior margin, posterior slope shorter, anterior slope more convex, and regular concentric costæ near the margin. *P. malonei* is more orbicular and larger than *P. navicelloides* Cpr.; and is smaller than *P. mirabilis* Sby. with finer sculpture and the apex nearer the posterior margin.

NOTE ON A COLLECTION OF FOSSILS FROM WILMINGTON, NORTH CAROLINA.

BY A. P. BROWN AND H. A. PILSBRY.

During a recent visit to Wilmington, N. C., Mr. Joseph Willcox collected a number of fossils from a quarry about one and a half miles east of the city.

The material is not well preserved, being mainly in form of internal casts, yet as the horizon has received but little attention, we have, at the request of Mr. Willcox, prepared the following list of species identified.[1]

Lunulites distans Lonsdale.
Flabellum cuneiforme Lonsdale. Cast.
Scutella lyelliana Emmons.
Echinolampas appendiculatus (determined by Prof. W. B. Clark).
Terebratula wilmingtonensis Lyell and Sowerby.
Pecten membranosus Morton.
Spondylus resembling *gregalis* Morton. Cast.
Crassatellites willcoxi n. sp.
Cytherea profunda Conrad. Cast.
Cypræa resembling *nuculoides* Aldrich. Casts.
"*Voluta*" sp. Cast.
Vasum wilmingtonense n. sp. Cast.
Aturia alabamiensis Conrad. Cast.
Pleurotomaria nixa (Tuomey).[2]

Crassatellites willcoxi n. sp. Pl. I, fig. 1.

The shell is large, oblong, the anterior end evenly rounded, posterior end subtruncate, beaks moderately elevated, at the anterior two-fifths of the length; somewhat compressed, the diameter a little less than half the length. Sculpture of rounded, subequal concentric ridges separated by narrower sulci. The valves are 3 to 5 mm. thick, where edges are exposed by fracture. There is no trace of a posterior ridge. The internal cast is smooth with very

[1] The fauna of the Wilmington beds was first, we believe, described by Professor Tuomey in an article entitled, "Description of some Fossil Shells from the Tertiary of the Southern States," PROC. A. N. S. PHILA., VI, pp. 192–194, 1852. Professor W. B. Clark has also treated briefly of it in *Bull. Geol. Soc. of America*, I, pp. 538–9, 1890.

[2] This specimen, in the museum of the Wagner Free Institute of Science, measures 7¼ inches in basal diameter.

faint traces of crenulation on the basal margin. The anterior adductor scar is raised in the cast and the posterior slightly sunken.

Length 105, alt. (as broken) 88 mm.

C. curta Conrad and *C. conradi* Whitfield, though very much smaller, are similar to this species in contour, but both seem to be smoother externally. *C. littoralis* Conrad is a similarly sculptured species, but it is more inequilateral and far smaller so far as known. *C. vadosa* Morton has the outline of *C. willcoxi*, except by its greater compression. Most of the American Tertiary *Crassatellites* are longer and more produced posteriorly than *C. willcoxi*.

Vasum wilmingtonense n. sp. Pl. I, figs. 2, 3.

This form is represented by an internal cast wanting the apical whorls, apparently derived from a species shaped like *V. haitense*. The conic spire diverges at an angle of about 80°, the crown of each whorl being narrowly rounded. The last whorl is much less convex above, being somewhat flattened and sloping to the rounded shoulder. The periphery, viewed from above, is polygonal; the last three angles on the last half whorl are prominent, but several on the first half are barely perceptible. Below the shoulder the sides taper to the narrow base, are a little swollen midway and contracted below the shoulder and near the base. Four deep furrows indicate as many stout columellar folds in the shell, the lowest one being somewhat smaller. The length of the cast is 113 mm. and the greatest diameter 66 mm.

In the absence of information as to the stratigraphic position of the specimens, we cannot say whether this species occurred with the preceding Eocene forms or, as seems more likely, in an overlying bed.

Correction.—The Editor regrets that, through an inadvertence, the name of Charles Morris was substituted for that of Effingham B. Morris on the Finance Committee (page 1).

APRIL 2.

MR. CHARLES MORRIS in the Chair.

Thirty-eight persons present.

The Publication Committee reported the reception of the following papers:

"Fixation of the Single Type (Lectotype) specimens of species of American Orthoptera, Part II." By A. N. Caudell and Morgan Hebard (March 28).

"The Relation of Plant Protoplasm to its Environment." By John Muirhead Macfarlane, D.Sc. (March 29).

The Chair announced the death, February 26, of Graceanna Lewis, a member.

DR. HENRY TUCKER made a communication on harmless and useful snakes, illustrated by lantern slides. (No abstract.)

The death of THOMAS HARRISON MONTGOMERY, JR., PH.D., having been announced at a previous meeting, the following minute, proposed by Dr. Philip P. Calvert, was unanimously adopted:

The Academy of Natural Sciences of Philadelphia has heard with deep regret of the death of PROF. THOMAS HARRISON MONTGOMERY, JR., on March 19, 1912.

Prof. Montgomery was a grandson of Samuel George Morton, President of this Academy from 1849–1851, widely known for his collection and studies of human craniology. To that ancestor we may trace Montgomery's taste for natural history which led him to study zoology in the University of Berlin (where he received the Ph.D. in 1894) and to fill positions of instruction and research in the Wagner Free Institute of Science, the Wistar Institute of Anatomy, the Woods Hole Marine Biological Laboratory and the Universities of Texas and of Pennsylvania. He was elected a member of this Academy February 23, 1897. He served on the Committee of Instruction and Lectures for 1903 and on the Committee on Accounts from 1909. He was the first to respond to the invitation to contribute to the Centenary Commemorative Volume and his memoir on Human Spermatogenesis was the last paper completed by him, although he did not live to read it at the anniversary meeting.

Barely thirty-nine years old when he died, he would have been

justified in a feeling of pride in what he had accomplished. He had made fruitful suggestions on the mechanism of inheritance based on his studies of minute details of the structure of the germ cells; he had investigated the anatomy of unsegmented worms, rotifers, and spiders; he had made known many interesting habits of spiders and of birds; his breadth of outlook and of zoological knowledge was displayed in his book on the analysis of racial descent in animals.

From all that he had done we rightfully expected much to come from his further researches, and our sorrow at his departure is made keener by his fulness of promise.

Moved that this be spread on the minutes of this meeting and that the Corresponding Secretary send a copy to Mrs. Montgomery.

April 16.

Philip P. Calvert, Ph.D., in the Chair.

Twenty-seven persons present.

The deaths of Miss Janes R. Haines, a member, November 11, 1911, and of Prof. Rudolph Bastian, a correspondent, were announced.

Dr. Spencer Trotter made a communication on some biological aspects of population. (No abstract.)

The following resolutions were adopted:

Resolved, That the Academy of Natural Sciences of Philadelphia finds much encouragement and stimulus in the expressions of cordial congratulation and recognition of its labors that reached it on the occasion of the celebration of the centenary anniversary of its foundation.

Resolved, That the Corresponding Secretary be instructed to convey to corresponding institutions and members an expression of the Academy's warm gratitude for their appreciation and courtesy.

The following were elected members:

John Ashhurst.
Seth Bunker Capp.
Walter N. James, M.D.
Philip F. Kelly.
Cecilia Baldwin McElroy.
A. V. Morton, M.D.
William H. Newbold.
Harold Peirce.
Hon. John M. Reynolds.
Samuel C. Schmucker.
Harriet Newell Wardle.

MAY 21.

CHARLES MORRIS in the Chair.

Nineteen persons present.

The meeting was held in conjunction with the Mineralogical and Geological Section.

The reception of the following papers was reported by the Publication Committee:

"Further Experiments with Mutations in Eye-color of Drosophila: The Loss of the Orange Factor," by T. H. Morgan (April 23).

"Some Aboriginal Sites on Red River," by Clarence B. Moore (April 29).

"On the Radiation of Energy," by James E. Ives (May 9).

"The Gorgonians of the Brazilian Coast," by A. E. Verrill (May 10).

"Tetraplasy, the Law of the Four Inseparable Factors of Evolution," by Henry Fairfield Osborn (May 18).

"Apparent Sun-crack Structures and Ringing-rock Phenomena in the Triassic Diabase of Eastern Pennsylvania," by Edgar T. Wherry (May 20).

"Lymnæa, Columella, and Self-fertilization," by Harold Sellers Colton (May 21).

The Triassic of Pennsylvania.—DR. EDGAR T. WHERRY spoke of the discovery of silicified wood, first described from Bucks County at a meeting three years ago, at a number of new localities as far west as Lancaster and York Counties. He also described observations along the north border of the area, where hills underlain by a coarse conglomerate are believed to represent delta deposits of rivers flowing from the north into the Triassic basin, although the large size and distant source of many of the pebbles suggests the possible activity of floating ice as a means of transportation. He further discussed certain phenomena connected with the diabase of the region, especially the formation of boulders and hexagonally arranged crack structures.

DR. F. BASCOM made a communication on the lavas of South Mountain, Pennsylvania. (No abstract.)

The following were ordered to be published:

FIXATION OF THE SINGLE TYPE (LECTOTYPIC) SPECIMENS OF SPECIES OF AMERICAN ORTHOPTERA.

DIVISION II.

BY A. N. CAUDELL and MORGAN HEBARD.

THE SPECIES OF NORTH AMERICAN ORTHOPTERA DESCRIBED BY ANDREW NELSON CAUDELL.

The desirability of selection and fixation of a single type was pointed out by the last International Entomological Congress, and the first paper on this subject with reference to the North American species of Orthoptera by Mr. James A. G. Rehn and the junior author of the present paper has recently appeared in the PROCEEDINGS OF THE ACADEMY OF NATURAL SCIENCES, 1912, pp. 60–128. In the preface to that paper the subject is discussed and method of selection of lectotypic specimens as followed in that contribution explained. In the present paper the work is made easy, owing to the fact that the author of all the species treated has selected from the typical series that specimen for single type which he would have selected at the time the species was described, had such action at that time been customary. The type numbers of the United States National Museum for Orthoptera are not available in fixing single types, though they are given in the original descriptions of all new species recently described or named from material belonging to that institution. This is due to the fact that in the Orthoptera Collection these type numbers do not refer to a single type, or to the male and female types of a species, but usually to the entire typical series. Of the seventy-five species described by the senior author which are found in North America, we find sixty-two single types in the United States National Museum, seven in the Museum of the Brooklyn Institute of Arts and Sciences, two in the Scudder Collection, and one each in the American Museum of Natural History of New York, the Saussure Collection, and the Morse Collection, while of one species the typical series is lost. At the present day all of these single types are extant, with the exception of the one mentioned as lost; those of the United States National Museum are in Riker Mounts. The nomenclature given is that of the original description,

as this paper is not intended to be in any way revisionary. All forms described by the senior author at the present date considered valid, and also all synonyms, are here treated.

SPONGOPHORA APICEDENTATA.

Proc. U. S. N. M., Vol. XXVIII, p. 461, fig. 1*a*, 1905.

Based on a pair from the same locality.

Single type here designated: figured ♂; Tucson, Arizona, January 14, on Giant Cactus, *Cereus gigantea;* H. G. Hubbard; U. S. N. M. Collection.

ANAPLECTA ABORTIVA.

Mus. Brooklyn Inst. Arts and Sci. Bulletin, Vol. I, No. 4, p. 105, 1904.

Described from a single female specimen from Esperanza Ranch, Brownsville, Texas, August 4, [1904]; [Chas. Schaeffer];[1] Mus. Brooklyn Inst. Arts and Sci. Collection.

HOMEOGAMIA BOLLIANA NIGRICANS.

Mus. Brooklyn Inst. Arts and Sci. Bulletin, Vol. I, No. 4, p. 107, 1904.

Based on several males from one locality.

Single type here designated: ♂; Esperanza Ranch, Brownsville, Texas, June [1903]; [C. Schaeffer]; Mus. Brooklyn Inst. Arts and Sci. Collection.

HOMEOGAMIA APACHA INFUSCATA.

Proc. U. S. N. M., Vol. XXVIII, p. 463, 1905.

Based on a single male from Phœnix, Arizona, June 4, 1904; Dr. R. E. Kunzé; U. S. N. M. Collection.

LATINDIA SCHWARZI.

Proc. Ent. Soc. Wash., Vol. V, No. 2, p. 165, 1903.

Described from three males from the same locality.

Single type here designated: ♂; Madera Canyon, Santa Rita Mountains, Arizona, July 7, 1898; E. A. Schwarz; U. S. N. M. Collection.

DIAPHEROMERA ARIZONENSIS.

Proc. U. S. N. M., Vol. XXVI, p. 877, 1903.

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[1] The use of brackets in the present paper indicates authentic information not contained in the original description.

Based on a unique male from Hot Springs, Arizona, June 28, 1901; E. A. Schwarz and H. S. Barber; U. S. N. M. Collection.

DIAPHEROMERA PERSIMILIS.

Mus. Brooklyn Inst. Arts and Sci. Bulletin, Vol. I, No. 4, p. 107, 1904.

Based on two males and one female from one locality.

Single type here designated: ♂; Esperanza Ranch, Brownsville, Texas, June [1903]; [Chas. Schaeffer]; Mus. Brooklyn Inst. Arts and Sci. Collection.

PSEUDOSERMYLE TRUNCATA.

Proc. U. S. N. M., Vol. XXVI, p. 869, Pl. LVIII, figs. 3–3*b*, 1903.

Described from a single female from Dos Cabezos, Arizona, June, 1891; U. S. N. M. Collection.

PSEUDOSERMYLE BANKSII.

Proc. U. S. N. M., Vol. XXVI, p. 871, 1903.

Based on two males from different localities.

Single type here designated: ♂; Brazos County, Texas, September; N. Banks; U. S. N. M. Collection.

BACUNCULUS BLATCHLEYI.

Jn. N. Y. Ent. Soc., Vol. XIII, p. 212, 1905.

Based on a pair from the same locality.

Single type here designated: unique ♂; Starke County, Indiana; W. S. Blatchley; U. S. N. M. Collection.

HOPLOLIBETHRA TUBERCULATA.

Mus. Brooklyn Inst. Arts and Sci. Bulletin, Vol. I, No. 4, p. 108, Pl. VI, figs. 1, 2, 1904.

Described from a unique female specimen from Esperanza Ranch, Brownsville, Texas, June 25, [1903]; [Chas. Schaeffer]; Mus. Brooklyn Inst. Arts and Sci. Collection.

APLOPUS MAYERI.

Jn. N. Y. Ent. Soc., Vol. XIII, p. 83, 1905.

Based on a pair from the same locality.

Single type here designated: ♂; Loggerhead Key, Dry Tortugas, Florida; Dr. A. G. Mayer; Mus. Brooklyn Inst. Arts and Sci. Collection.

ACHURUM MINIMIPENNE.

Mus. Brooklyn Inst. Arts and Sci. Bulletin, Vol. I, No. 4, p. 110, Pl. VI, Figs. 3, 4, 1904.

Based on a unique female from Brownsville, Texas, April 22, [1903]; [Chas. Schaeffer]; Mus. Brooklyn Inst. Arts and Sci. Collection.

LIGURUROTETTIX KUNZEI.

Proc. Ent. Soc. Wash., Vol. V, No. 2, p. 162, 1903.

Based on a pair from the same locality.

Single type here designated: unique ♂; Phœnix, Arizona, September 10, 1902; Dr. R. E. Kunzé; U. S. N. M. Collection.

CHIMAROCEPHALA PACIFICA OBTUSA.

Proc. Ent. Soc. Wash., Vol. VII, Nos. 2, 3, p. 124, 1906.

Based on a single male from Monterey County, California, August, 1903; Coleman; U. S. N. M. Collection.

CHIMAROCEPHALA PACIFICA INCISA.

Proc. Ent. Soc. Wash., Vol. VII, Nos. 2, 3, p. 124, 1906.

Based on material misidentified as *Chimarocephala pacifica* Thomas, by Saussure; from one locality.

Single type here designated: ♀; California, Saussure Collection.

ENCOPTOLOPHUS SUBGRACILIS.

Proc. Ent. Soc. Wash., Vol. V, No. 2, p. 163, 1903.

Based on two males and one female from a single locality.

Single type here designated: ♂; Phœnix, Arizona, October 27, 1902; Dr. R. E. Kunzé; U. S. N. M. Collection.

LACTISTA OSLARI.

Proc. U. S. N. M., Vol. XXVIII, p. 468, 1905.

Described from a unique male specimen from Nogales, Arizona, July 3, 1903; E. J. Oslar; U. S. N. M. Collection.

MESTOBREGMA GRACILIPES.

Proc. U. S. N. M., Vol. XXVIII, p. 471, fig. 5, 1905.

Described from two males and two females from two localities.

Single type here designated: figured ♀; Huachuca Mountains, Arizona, August 25, 1903; E. J. Oslar; U. S. N. M. Collection.

MESTOBREGMA THOMASI.

Proc. Ent. Soc. Wash., Vol. VI, No. 2, p. 125, 1904.

Based on material misidentified as *Œdipoda cincta* Thomas, by Bruner, Scudder, etc.

Single type here designated; figured[2] ♀; no data. Type lost.

ARÆOPTERYX PENELOPE.

Can. Ent., Vol. XXXIII, p. 102, 1901.

Based on a single female specimen from Prescott, Arizona, September 29, 1900; Dr. R. E. Kunzé; U. S. N. M. Collection.

PSINIDIA SULCIFRONS[3] AMPLICORNUS.

Proc. U. S. N. M., Vol. XXVI, p. 791, Pl. LV, fig. 2, 1903.

Based on a pair from the same locality.

Single type here designated: unique figured ♀; Victoria, Texas, June, 1902; Caudell; U. S. N. M. Collection.

TRIMEROTROPIS SCHAEFFERI.

Mus. Brooklyn Inst. Arts and Sci. Bulletin, Vol. I, No. 4, p. 112, Pl. VII, fig. 1, 1904.

Described from two males from the same locality.

Single type here designated: figured ♂; Topo, near Brownsville, Texas, May [1903]; [Chas. Schaeffer]; Mus. Brooklyn Inst. Arts and Sci. Collection.

TRIMEROTROPIS TITUSI.

Proc. Ent. Soc. Wash., Vol. VII, Nos. 2, 3, p. 125, 1906.

Based on eight males and three females from the same locality.

Single type here designated: ♂; Spreckles, Monterey County, California, September 20, 1904, on sugar beets; E. S. G. Titus; U. S. N. M. Collection.

HELIASTUS BENJAMINI.

Proc. U. S. N. M., Vol. XXVIII, p. 474, fig. 6, 1905.

Based on one male and two females from two localities.

Single type here designated: figured ♀; Huachuca Mountains, Arizona, August 16, 1903; E. J. Oslar; U. S. N. M. Collection.

HELIASTUS SUMICHRASTI SUBROSEA.

Proc. U. S. N. M., Vol. XXVII, p. 951, fig. 3, 1904.

Based on a pair from a single locality.

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[2] This figure is very good, excepting the fact that the wing has the transverse band drawn too near its apex.

[3] This should be *fenestralis*, correction made, *Can. Ent.*, Vol. XXXVIII, p. 204, 1906.

Single type here designated: unique figured ♂; Galveston, Texas, [April, 1903]; C. Schaeffer; U. S. N. M. Collection.

HELIASTUS GUANIERI.

Proc. U. S. N. M., Vol. XXVI, p. 794, Pl. LV, fig. 3, 1903.

Based on specimens of both sexes representing two localities.

Single type here designated: figured ♀; Pueblo, Colorado, October, 1877; G. F. Guanier; U. S. N. M. Collection.

BARYTETTIX BOREALIS.

Proc. Ent. Soc. Wash., Vol. IX, Nos. 1–4, p. 69, 1908.

Based on two males and one female from probably two localities.

Single type here designated: ♂; base of Santa Catalina Mountains, Arizona, August 16, 1907; J. L. Webb; U. S. N. M. Collection.

ÆOLOPLUS BRUNERI.

Proc. Ent. Soc. Wash., Vol. VIII, Nos. 3, 4, p. 134, 1907.

Based on material misidentified as *Caloptenus regalis* Dodge, by Scudder. Type located P. A. N. S. P., 1912, p. 76.

MELANOPLUS BROWNII.

Can. Ent., Vol. XXXIV, p. 169, 1902.

Described from three pairs from one locality.

Single type here designated: ♂; few miles up Colorado River from Yuma, Arizona, December 8, 1901, at head of dry slough; Herbert Brown; U. S. N. M. Collection.

MELANOPLUS COLORADUS.

Proc. U. S. N. M., Vol. XXVI, p. 799, Pl. LV, figs. 1, 1*a*, 1903.

Described from a single male from Palisade, Colorado, elevation 4741 feet, July 8, 1901; Caudell; U. S. N. M. Collection.

MELANOPLUS INCONSPICUUS.

Trans. Am. Ent. Soc., Vol. XXVII, p. 87, 1902.

Based on a unique male from the Creek Nation, Indian Territory, near Arlington, Oklahoma, May 31, 1901; Mrs. Nellie Caudell; U. S. N. M. Collection.

MELANOPLUS LATIFERCULA.

Proc. U. S. N. M., Vol. XXVI, p. 802, Pl. LV, figs. 4, 4*a*, 1903.

Based on a single male specimen from Cumbres, Colorado, elevation 10,015 feet, August 14, 1901; Caudell; U. S. N. M. Collection.

MELANOPLUS SONOMÆNSIS.

Proc. Ent. Soc. Wash., Vol. VII, Nos. 2, 3, p. 124, 1906.

Based on a pair from the same locality.

Single type here designated: unique ♂; Glenellen, Sonoma County, California, [September 18, 1904], on rocky hillside; E. S. G. Titus; U. S. N. M. Collection.

ASEMOPLUS RAINIERENSIS.

Proc. Ent. Soc. Wash., Vol. VIII, Nos, 3, 4, p. 134, 1907.

Based on a pair taken in coitu from a large series of both sexes from a single locality.

Single type here designated: ♂ taken in coitu; Paradise Valley, Mount Rainier, Washington, July 31, 1906, in low, rank, green, grasses; Dyar and Caudell; U. S. N. M. Collection.

AMBLYCORYPHA ISELYI.

Jn. N. Y. Ent. Soc., Vol. XIII, p. 50, 1905.

Described from two pairs from a single locality.

Single type here designated: ♂; Wichita, Kansas, July [29], 1904; Professor Isely; U. S. N. M. Collection.

PARACYRTOPHYLLUS ROBUSTUS.

Jn. N. Y. Ent. Soc., Vol. XIV, p. 36, Pl. I, figs. 1, 6, 1906.

Described from three males and two females from one State.

Single type here designated: figured ♂; Texas; U. S. N. M. Collection.

CYRTOPHYLLUS ELONGATUS.

Jn. N. Y. Ent. Soc., Vol. XIV, p. 40, 1906.

Described from a pair from two localities.

Single type here designated: ♂; Fountain County, Indiana, August [12, 1904]; W. S. Blatchley; U. S. N. M. Collection.

CYRTOPHYLLUS FURCATUS.

Jn. N. Y. Ent. Soc., Vol. XIV, p. 41, Pl. I, fig. 9, 1906.

Based on a single figured male specimen from West Point, Nebraska [in Court House grounds], [in high trees], [late August, 1898]; [J. C. Crawford]; U. S. N. M. Collection.

CYRTOPHYLLUS INTERMEDIUS.

Jn. N. Y. Ent. Soc., Vol. XIV, p. 41, Pl. I, fig. 8, 1906.

Based on a pair from different localities.

Single type here designated: unique figured ♂.; Biloxi, Mississippi; Alice Tracy; U. S. N. M. Collection.

XIPHIDION ALLARDI.

Ent. News, Vol. XXI, p. 58, 1910.

Described from two pairs from one locality.

Single type here designated: ♂; Tray Mountain, Towns County, North Georgia, elevation 4,389 feet, late September, in low weeds and short grass; H. A. Allard; U. S. N. M. Collection.

NEDUBA CARINATA CONVEXA.

Proc. U. S. N. M., Vol. XXXII, p. 300, fig. 10, 1907.

Described from a pair from different localities.

Single type here designated: figured ♂; Mount Shasta, California; Behrens; U. S. N. M. Collection.

NEDUBA MORSEI.

Proc. U. S. N. M., Vol. XXXII, p. 301, fig. 11, 1907.

Based on a unique figured male specimen from Mount Wilson [*nec* Altadena], California, July 27, [1897]; A. P. Morse; Morse Collection.

REHNIA VICTORIÆ.

Proc. U. S. N. M., Vol. XXXII, p. 306, figs. 14, 15, 1907.

Based on a unique figured male from Victoria, Guerrero, Mexico; O. W. Barrett; U. S. N. M. Collection.

REHNIA SPINOSA.

Proc. U. S. N. M., Vol. XXXII, p. 307, figs. 16, 17, 1907.

Based on a unique figured male from Texas; U. S. N. M. Collection ex Bruner.

ZACYCLOPTERA ATRIPENNIS.

Proc. U. S. N. M., Vol. XXXII, p. 309, figs. 18, 19, 1907.

Described from a unique figured male specimen from Hawthorne, Nevada, June; Wickham; U. S. N. M. Collection ex Bruner.

CAPNOBOTES OCCIDENTALIS UNIFORMIS.

Proc. U. S. N. M., Vol. XXXII, p. 317, 1907.

Described from a unique figured male specimen from Los Angeles County, California, July; Coquillett; U. S. N. M. Collection.

APOTE NOTABILIS ROBUSTA.

Proc. U S. N. M., Vol. XXXII, p. 330, fig. 34, 1907.

Based on an unspecified number of specimens apparently from Washington.

Single type here designated: figured ♂; Rockland, Washington, July 4, [1897]; W. K. Fisher; U. S. N. M. Collection.

Eremopedes balli.

Can. Ent., Vol. XXXIV, p. 100, 1902.

See Caudell, *Proc. U. S. N. M.*, Vol. XXXII, p. 335, 1907, for correct limitation.

Based on six males and two females from two localities in Arizona.

Single type here designated: ♂; Williams, Arizona, July, 1901; H. S. Barber and E. A. Schwarz; U. S. N. M. Collection.

Eremopedes (?) brevicauda.

Proc. U. S. N. M., Vol. XXXII, p. 336, fig. 39, 1907.

Described from a unique figured female from Napa County, California; H. Edwards; Am. Mus. Nat. Hist. Collection.

Stipator bruneri.

Proc. U. S. N. M., Vol. XXXII, p. 343, 1907.

Based on two males and five females from Texas.

Single type here designated: ♂; Texas, [July 14]; Belfrage; U. S. N. M. Collection.

Orchesticus nigromarginata.

Trans. Am. Ent. Soc., Vol. XXVIII, p. 89, 1902.

Described from a unique female from Texas, [January 5]; Belfrage; U. S. N. M. Collection.

Stipator nigromarginatus griseis.

Proc. U. S. N. M., Vol. XXXII, p. 347, 1907.

Based on a series from one or more localities.

Single type here designated: ♂; Haigler, Nebraska; Carriker; U. S. N. M. Collection ex Bruner.

Stipator grandis insignis.

Proc. U. S. N. M., Vol. XXXII, p. 349, fig. 45, 1907.

Based on one male and three females from one locality.

Single type here designated: unique figured ♂; Dallas, Texas; U. S. N. M. Collection.

Stipator mitchelli.

Can. Ent., Vol. XLIII, p. 137, fig. 7, 1911.

Based on a unique figured male from Hondo, Texas, March 30, 1908, eating petals of *Opuntia* flowers; J. D. Mitchell; U. S. N. M. Collection.

ANABRUS SIMPLEX NIGRA.

Proc. U. S. N. M., Vol. XXXII, p. 355, 1907.

Based on six males and eight females from four localities.

Single type here designated: ♂; Eddy, Routt [*nec* Route] County, Colorado; U. S. N. M. Collection.

ANABRUS SIMPLEX MACULATUS.

Proc. U. S. N. M., Vol. XXXII, p. 356, 1907.

Described from eleven males and fourteen females from five localities.

Single type here designated: ♂; Fort Walsh, British Columbia, September; U. S. N. M. Collection.

ANABRUS CERCIATA.

Proc. U. S. N. M., Vol. XXXII, p. 361, fig. 48, 1907.

Based on a pair from different localities.

Single type here designated: figured ♂; Washington; Morrison; U. S. N. M. Collection ex Bruner.

ANABRUS LONGIPES.

Proc. U. S. N. M., Vol. XXXII, p. 361, 1907.

Based on one male and two females from the same locality.

Single type here designated: unique ♂; Pullman, Washington, August; C. V. Piper; U. S. N. M. Collection.

ATELOPLUS MINOR.

Proc. U. S. N. M., Vol. XXXII, p. 371, fig. 56, 1907.

Based on a unique figured female specimen from Oracle, Arizona, June 29, [1898]; E. A. Schwarz; U. S. N. M. Collection.

ATELOPLUS SCHWARZI.

Proc. U. S. N. M., Vol. XXXII, p. 372, fig. 58, 1907.

Described from a pair from the same locality.

Single type here designated: figured ♂; Tinajas Altas, Arizona, [1905]; McGee; U. S. N. M. Collection.

ATELOPLUS LUTEUS.

Proc. U. S. N. M., Vol. XXXII, p. 373, fig. 59, 1907.

Based on a pair from the same locality.

Single type here designated: unique figured ♂; Mohave, Arizona; Wickham; U. S. N. M. Collection.

IDIOSTATUS REHNI.

Proc. U. S. N. M., Vol. XXXII, p. 382, fig. 70, 1907.

Based on two males and one female from one locality.

Single type here designated: figured ♂; Siskiyou County. California; A. Koebele; U. S. N. M. Collection.

IDIOSTATUS ELEGANS.

Proc. U. S. N. M., Vol. XXXII, p. 384, figs. 71, 72, 1907.

Described from a pair from Nevada.

Single type here designated: unique figured ♂; [Reno], Nevada; F. H. Hillman, [June 15, 1890]; U. S. N. M. Collection ex Bruner.

IDIOSTATUS VARIEGATA.

Proc. U. S. N. M., Vol. XXXII, p. 387, 1907.

Based on a unique female from Pocatello, Idaho; U. S. N. M. Collection ex Bruner.

PLAGIOSTIRA ALBONOTATA BREVIPES.

Proc. U. S. N. M., Vol. XXXII, p. 392, 1907.

Based on a pair from the same locality.

Single type here designated: unique ♂; Williams, Arizona, July 24, 1901, on sagebrush; H. S. Barber; U. S. N. M. Collection.

PLAGIOSTIRA GILLETTEI.

Proc. U. S. N. M., Vol. XXXII, p. 392, fig. 77, 1907.

Described from a unique figured male specimen from Grand Junction, Colorado, June 20, 1905; C. P. Gillette; U. S. N. M. Collection.

IDIONOTUS BREVIPES.

Proc. U. S. N. M., Vol. XXXII, p. 396, fig. 81, 1907.

Described from a single figured male from Arctic America; Kennicott; Scudder Collection.

PLATYCLEIS FLETCHERI.

Proc. U. S. N. M., Vol. XXXII, p. 403, fig. 87, 1907.

Described from a unique female from Calgary, Assiniboia, Canada, U. S. N. M. Collection.

CLINOPLEURA MINUTA.

Proc. U. S. N. M., Vol. XXXII, p. 402, fig. 86, 1907.

Based on two pairs from a single locality.

Single type here designated: figured ♂; Calaveras [County], California; U. S. N. M. Collection.

Cyphoderris monstrosus piperi.

Jn. N. Y. Ent. Soc., Vol. XII, p. 53, 1904.

Based on one adult male and two female nymphs from a single locality.

Single type here designated: unique ♂; Paradise Valley, Mount Rainier, Washington, elevation 6,000 feet, in grove of Alpine fir; C. V. Piper; U. S. N. M. Collection.

Marsa tuberculata.

Proc. U. S. N. M., Vol. XXXIV, p. 79, 1908.

Based on a pair from the same locality.

Single type here designated: unique ♂; Eureka, California, July 5, 1906, under loose bark of old tree near ground; Caudell; U. S. N. M. Collection.

Daihinia phrixocnemoides.

Ent. News, Vol. XVIII, p. 11, figs. 1, 1*a*, 1907.

Described from a unique figured female specimen from Mesilla Park, New Mexico, August 12, 1898; Cockerell; U. S. N. M. Collection.

Nemobius fasciatus abortivus.

Can. Ent., Vol. XXXVI, p. 248, 1904.

About three dozen specimens of both sexes from one locality.

Single type here designated: ♂; Moose Jaw, Assiniboia, August 24, 1903, in grass, in and along borders of draw on prairie; Caudell; U. S. N. M. Collection.

Miogryllus oklahomæ.

Trans. Am. Ent. Soc., Vol. XXVIII, p. 90, 1902.

Based on a single male specimen from Perkins, Oklahoma, May 16, 1901; Mrs. Nellie Caudell; U. S. N. M. Collection.

Cyrtoxipha columbiana.

Jn. N. Y. Ent. Soc., Vol. XV, p. 237, 1907.

Based on a pair from different localities.

Single type here designated: unique ♂; Falls Church, Virginia, September 14, 1907; N. Banks; U. S. N. M. Collection.

APPARENT SUN-CRACK STRUCTURES AND RINGING-ROCK PHENOMENA IN THE TRIASSIC DIABASE OF EASTERN PENNSYLVANIA.

BY EDGAR T. WHERRY, PH.D.

The rocks deposited during the Triassic period in eastern North America, variously known as the New Red, Newark, and Jura-Trias, cross the State of Pennsylvania in a northeast-southwest strip averaging twenty miles in width. While they have in the past been the subject of considerable investigation, some of their most interesting features are as yet undescribed.[1]

About the middle of the 20,000 feet of sediments representing the period in Montgomery County there occurs a sill of diabase, which, although greater in size than the Palisade sheet of New Jersey, has attracted far less attention since it does not happen to be so located as to give rise to striking scenic effects. The total length of outcrop of this sill being over 40 miles, it would be strange if there were not a few exposures of its contact relations with the sediments, even in the absence of a great metropolis nearby as an inducement for railroad companies to pierce it by numerous cuts and tunnels; and, in fact, its upper contact has been observed at several localities northeast of the city of Pottstown. The rock surfaces exposed at these places by the removal of the metamorphosed shale beds present a rather startling appearance, being crossed by a rudely hexagonal network of light-colored lines, closely resembling sun-cracks such as are frequently found in the sediments. The best exposure, a photograph of which is shown in figure 1, Plate II, is on the east side of a road, opposite the house of Alexander C. Minshall, one-half mile north of Neiffer Post Office, which lies about three miles north of Limerick Square and two miles west of Zieglersville.

[1] The writer has been engaged for several years in studying the portion of this area lying east of the Susquehanna River, and has previously published two papers upon it: "The Newark Copper Deposits of Southeastern Pennsylvania," *Econ. Geol.*, III, 726–38, 1908; and "Contributions to the Mineralogy of the Newark Group in Pennsylvania," Thesis, University of Pennsylvania, 1909, *Trans. Wagner Free Inst. Science*, VII, 1–23, 1910. An abstract of this paper was read at the Pittsburgh meeting of the Geological Society of America, December, 1910, and published in *Bull. Geol. Soc. Amer.*, XXII, 718, 1911; and in completed form it was presented at the meeting of the Academy in association with the Mineralogical and Geological Section, May 21, 1912.

There can be no question, however, as to the igneous origin of the rock. When studied in thin section it is found to consist of interlacing laths of labradorite surrounded by augite similar to the contact facies of Triassic diabases which have been described elsewhere.[2] The lines turn out to be dikes, composed of coarser crystals of the same minerals (fig. 3, Plate II). These dikes vary from ½ to 5 mm. in thickness, and penetrate into the rock to depths of several centimeters, gradually losing their identity as the size of grain of the background increases.

The explanation of this occurrence is apparently to be found in the tendency of magmas to contract on solidifying, exemplified in the well-known columnar structure of many basalts. In the course of the intrusion of the magma the outer portions were rapidly chilled by the cold wall-rocks, and solidified in correspondingly fine-grained form. At the same time there developed, perpendicular to the contact surfaces, hexagonally arranged shrinkage cracks. Into these the still liquid material beneath found its way, but since in the meantime the surroundings had become heated, cooling was now less rapid and larger crystals were formed.

The boulders which everywhere characterize the diabase areas often show on their surface a hexagonal-crack effect resembling at first sight that just described (fig. 2, Plate II). The two phenomena are, however, quite distinct, for thin sections of the rock beneath these cracks fail to indicate the existence of any structural peculiarity (fig. 4, Plate II), and the cracking is evidently caused by expansion of the surface layers during the exfoliation of the boulders under the action of frost.

The striking similarity of these two effects to one another, and of both to sun-cracks, is due, then, to the fact that all three have their origin in tension exerted uniformly in a plane, the normal result of which is, as is well known, the development of cracks at approximate angles of 120 degrees.

The blocks of diabase are occasionally collected into "boulder fields"—in Germany termed Felsenmeere, or rock seas—tracts often an acre or more in extent, which are practically barren of vegetation (because of the absence of soil), in striking contrast to most of the surrounding region (fig. 7, Plate II). Many of the boulders ring like a metal when struck, and under the name of "ringing-rocks" have attracted considerable attention from the inhabitants of the neighbor-

[2] Lewis, J. V.: *Ann. Rept., State Geol., New Jersey*, 1907, 115, pl. XVI.

hood, many a fantastic theory having been advanced to account for their formation. The principal localities of these ringing-rock fields are:

Narrowsville, Bucks County, on the edge of the plateau south of the Delaware River, 3 miles east of Kintnersville.

Shelly, Bucks County, 2½ miles northeast of the railroad station.

Spring Mount, Montgomery County, east of the Perkiomen Creek, one mile above Schwenksville.

Ringing Rocks Park, 2 miles northeast of Pottstown.

Blue-Rocks, 1 mile east of Elverson Station, Chester County.

Although most of these places are rather widely known and are frequently visited by outing parties, curiously enough no scientific description of them appears to have ever been published.

The manner of formation of the large rounded rock masses known as boulders, as described in text-books of geology, is as follows: The solid rocks at or near the earth's surface are traversed by numerous cracks, or "joints," usually intersecting in such a way as to divide them into roughly rectangular or rhomboidal blocks. Rain water, percolating downward along these joints, attacks and gradually decomposes the rock constituents, but since at the intersections of planes the action can take place in several directions at once, edges yield twice, and corners three times as rapidly as the flat surfaces, and as a result the ultimate shape attained by the blocks is that of a spheroid (fig. 8, Plate II).

Boulders thus developed usually remain surrounded by weathered rock fragments or the derived soil; but when running water finds its way around them, this finer material may be removed, leaving them exposed to view. Study of the above-mentioned occurrences has shown that this explanation is adequate to account for their formation. The boulder fields are always found at or near the base of the sheet of igneous rock, where the intensely metamorphosed underlying sediments form an impervious pavement over which streams of water flow; this can sometimes be heard, or even seen, through spaces between the blocks. Their exact position is determined by local conditions, such as the dip of the strata, which apparently must be less than 30°, the configuration of the hills, which affects the flow of the streams, and perhaps other factors. But the point calling for particular emphasis, in view of the popular opinion about the matter, is that there has been absolutely no "upheaval" or other violent disturbance to bring the boulders together, but that they have, quite to the contrary, been formed by the gradual breaking up and

washing away of material from the solid rocks originally occupying the ground.

The cause of the ring of the boulders when struck is no doubt to be sought in the peculiar rock texture. As seen in thin sections (fig. 5, Plate II), the feldspar crystals interlace to form a close network in which sound waves can readily develop. But this alone is not sufficient—the boulders must also be supported so as to be able to vibrate freely, just as is necessary with a bell, for thin sections of two of them found side by side, one ringing finely, the other not at all, show absolutely no textural difference (figs. 5 and 6, Plate II), but the former was loosely supported, and the latter wedged firmly, between other blocks.

It is to be concluded, then, that the "ringing-rocks" consist of boulders formed in the places where they are found by simple, normal processes of weathering and that their ringing qualities are due to the texture of the diabase rock of which they are composed.

Explanation of Plate II.

Fig. 1.—Sun-crack-like structure, upper surface of diabase sill, north of Neiffer P. O., Montgomery County, Pa.

Fig. 2.—Boulder of diabase showing exfoliation cracks, near summit of Spring Mount, Montgomery County, Pa.

Fig. 3.—Thin section of the rock of fig. 1, showing fine-grained diabase traversed by more coarsely crystallized dike. Crossed nicols. × 20.

Fig. 4.—Thin section beneath an exfoliation crack, showing uniform size of grain, the lighter color along the crack being due to decomposition of augite, etc. Ordinary light. × 20.

Fig. 5.—Thin section of a rock yielding fine ring, Ringing Rocks Park. The banded crystals are plagioclase feldspar, the gray patches chiefly augite. Crossed nicols. × 20.

Fig. 6.—Same, from a boulder adjacent to the preceding, which failed to ring; entirely similar as to minerals and structure.

Fig. 7.—Boulder field, Ringing Rocks Park, northeast of Pottstown, Montgomery County.

Fig. 8.—Boulder formation in diabase, quarry at St. Peters, Chester County, Pa.

LYMNÆA COLUMELLA, AND SELF-FERTILIZATION.

BY HAROLD SELLERS COLTON.

The following paper is a preliminary study of the pond snail, *Lymnœa columella* Say, with the particular view of its furnishing material for the study of genetics. We should look to this form because of the probability that when isolated from one another, the eggs that are laid are self-fertilized. No studies have yet been made on animals that reproduce by self-fertilization, so that, as pointed out by Jennings, 1911 B, no work on animals can be directly compared with that on plants.

Notwithstanding the many means by which hermaphroditic animals prevent self-fertilization, a number of cases are well known where normally self-fertilization does occur. As an example of this the following groups may be quoted: Rhabdocoel Turbellarians, Sekera 1906; Polystomum, Zeller 1876;[1] the digenetic Trematodes, Leucart, v. Siebold, Zaddock, Voeltzkow, and others; the Cestodes, Loess, Carlisle, Schultze, Bellingham, van Beneden, Pagenstecher, Leuckhart,[2] and others; the Ascidians *Cynthia* and *Molgula*, Morgan 1904; *Botryllus*, Pizon 1893; and the pond snail *Lymnœa*.

This paper will not discuss the adaptability of the material from the Flat Worms or the Ascidians for breeding experiments. Parasites and marine animals furnish great difficulties at the outset for such a study, and Rhabdocoels reproduce also asexually, so we will turn at once and consider the case of the pond snail.

The first point to be determined is: Does *Lymnœa* self-fertilize its eggs? Oken (1817)[3] isolated an individual adult *Lymnœa*. After an interval of some months this snail laid fertile eggs. Oken concluded that this was a case of self-fertilization. Von Ihring (1876) showed how in many gastropods, *Helix*, for example, a long period, as much as a year, may intervene between copulation and egg-laying. Because of this he did not consider Oken's experiment of any value.

[1] See Bronn, 1899 and 1900.
[2] See Bronn, 1899 and 1900.
[3] See Braun, 1888.

In the meantime von Baer (1835) reported an observation which seemed to confirm Oken's view. He actually saw *Lymnæa auricularia* with own penis inserted in its own female opening. Braun (1888) isolated eggs of *Lymnæa auricularia* in separate vessels and raised the young snails which when they reached adult size laid eggs which developed. Although this author had the snails under observation for weeks and months at a time, he never was able to confirm von Baer. Nevertheless, he did not doubt that von Baer was correct in what he saw. The present writer has repeatedly isolated eggs and had them develop into snails which laid fertile eggs, but has never witnessed a case of self-copulation.

There is the alternative that must be disposed of: Can it be that these eggs are not self-fertilized, but that they develop parthenogenetically? This question cannot as yet be fully answered. To be sure, normal parthenogenesis is unknown in mollusks, but direct evidence on the case in *Lymnæa* is lacking. The reduced number of chromosomes in maturation of the sperm is small, six to eight, but as yet the writer has been unable to satisfactorily imbed the eggs so that they may be cut. As yet he has been unable to observe the first cleavage figures.

An examination of the reproductive organs of the snail will show that there is no reason why self-fertilization should not occur. This system is a complicated one in the lung-bearing mollusks, and *Lymnæa* is no exception to the rule. The eggs and sperm arise side by side in a common ovitestis. When ripe both eggs and sperm pass down a common hermaphrodite duct. Into this duct the albumen gland opens, the function of which is to secrete around the egg a thick coat of albumen. This is the substance which makes the eggs so difficult to imbed. Past this point the duct divides into a thread-like vas deferens with wider portion called the prostate gland, and a thicker-walled oviduct. The former leads finally to an invertible penis just back of the tentacle on the right side of the animal, while the oviduct opens somewhat to the exterior somewhat posterior to the former with a narrow slit. Into the oviduct near its aperture opens the duct from the so-called sperm receptacle, in which the writer has never found sperm, but in which very often he has found eggs. He hopes to deal with this matter at another time.

The reason for describing in some detail the reproductive organs of this animal is to make clear that there is every piece of mechanism present to allow self-fertilization. If the eggs are not fertilized in the upper part of the oviduct, they may be by self-copulation in the lower part.

The fact that self-copulation had been observed by no other observer than the great von Baer, the fact that a case of parthenogenesis is as yet unreported in the group of the mollusks, together with the fact that there is every arrangement present in the animal to make self-fertilization possible—all these seem to the writer sufficient evidence that the chance that parthenogenesis plays a part is remote. This must not be taken as precluding this remote possibility.

Are these animals easy to handle in a breeding experiment? This question may be answered, on the whole, yes.

In 1908 the writer (Colton, 1908) published the results of a series of experiments on the pond snail *Lymnæa columella*, showing the effects of various external conditions upon the growth. Among other things, the writer found how easy it is to raise *Lymnæa* from the egg under ordinary laboratory conditions. They will live in as little as 500 cc. of water and require next to no care. Philadelphia city water from the tap was found to be fatal to the young snails, but the same water, after standing in a large aquarium for some time, could then be used. In his experiments this winter even this water proved fatal, so that water had to be procured from the nearby pond in the Botanical Garden of the University. In the previous experiments a water plant, *Myriophyllum*, and a little soil seemed to offer the optimum conditions for growth, aeration being neglected. This winter the writer has had the best results in using dead leaves of trees from the bottom of the pond referred to above. These were washed in running tap water as a precaution against introducing young snails from the pond. The best results are now procured by using about 700–1000 cc. of pond water in a battery jar and placing in this a half-decayed leaf, such as a maple leaf. One snail only is of course placed in the jar.

The length of time that it takes from hatching to egg-laying varies greatly. As the cause of this variation is not understood at all, it will be at the present time worth while to mention only some of the cases. Thirteen had the following interval from hatching to egg-laying: 32, 26, 35, 49, 58, 92, 50, 50, 56, 57, 63, 74, and 74 days. Twenty-six days was the shortest interval. This shows, even if we neglect the shortest periods, how surprisingly rapid is the growth. As for ease of handling in a laboratory, *Lymnæa columella* is seen to furnish splendid material. They require little care, little space, and come to maturity promptly.

What are the characters that distinguish the various species and

varieties of *Lymnæa* from one another, and what is the character of the variation within one species?

The most recent work on the systematic relationships of the various species and varieties of *Lymnæa* is the monograph on the group by F. C. Baker (1911). This writer recognizes one hundred and two recent species and varieties which he distributes through six genera as follows: *Lymnæa*, two species and three varieties; *Radix*, one species; *Bulimnæa*, one species; *Acella*, one species; *Galba*, fifty-eight species and twenty-eight varieties. The characters on which these genera are distinguished from one another are as follows: the relative size of portions of the male reproductive organs, whether there are one or two penis sac retractors; whether there are two or three cusps on the lateral teeth; proportions of the jaws, length of the spire, axis of the shell gyrate or not, sculpture of the surface, etc. It will be noticed that all these characters, with the exception of two, are purely quantitative. The character of the teeth is a qualitative difference to which the author attributed little importance, as his *Galba obrussa* has the same type of radula as his *Pseudosuccinea columella* when the latter is half-grown. There is no qualitative difference between the radulæ of the adults. Many *Galba* have tri- and other *Galba* have bi-cuspid lateral teeth. Of the one hundred and two species and varieties, of but thirty-two did the writer know aught of the anatomy of the reproductive organs. Nothing is apparently known of the internal anatomy of the type species of the genus *Galba*, that is, *Galba truncatula* Muller. Since the important characters in describing the genera are purely quantitative, the present writer feels that he cannot accept these genera and will for the present consider the old genus *Lymnæa* as including them all. When we know more, some genera may, perhaps, be farther separated. Not being a systematist, the author cannot criticise this work and he is very thankful that someone has taken the trouble to examine all the literature and the species of this interesting group, bringing it together in one work.

The individual species are separated one from the other by quantitative differences in the shell characters, body characters, by color, and where known the genital organs, the radula, and jaw. This roughly outlines the sort of variation that takes place within the genus. Within a single species what can we look for?

In the present case, where selection is hoped to be practiced, characters visible on the exterior can alone be considered. This forbids us at the outset dealing with any characters of the internal

organs. In the snail the shell at once presents itself. So far we have considered the shell alone.

Adams, 1900, made a careful study of the fresh-water prosobranch mollusk *Io* taken from many stations on the same watershed. He measured the height of the spine, the length of the aperture and width of the shell. In the present study three characters were also measured. These were chosen so that when their ratios were plotted a picture of the average shape of the shells of the colony from which the collections were made would result.

The length of the spire of the shell may be expressed by the ratio—altitude to length of aperture. See fig. 1, where $\frac{AB}{BC}$ this ratio. The width of the shell may be expressed roughly in terms of a ratio, length of the aperture to the width. The former ratio $\frac{AB}{BC}$ we will refer to as the *ratio*, and the latter ratio we will refer to as the *index*.

Using the measurements furnished by Baker, 1911, which are probably measurements of extreme individuals, calculating their *index* and *ratio* and plotting them, using the *index* as an ordinate and the *ratio* as the abscissa, when these are enclosed by a line, then we have a rough picture of the shape of the shell. Fig. 2 shows such a picture and the dark oval represents *Lymnæa columella* as it occurs about Philadelphia as compared with some forms taken from Baker's measurements.

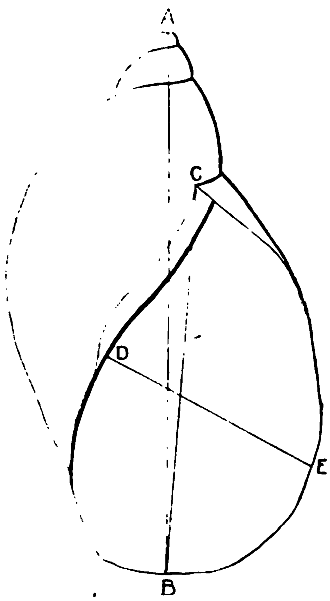

Fig. 1.

The writer made a number of collections of *Lymnæa columella* from some ponds and streams about Philadelphia, and also examined several series in the collection of the Academy of Natural Sciences of Philadelphia.[4] The three characters referred to above were measured with proportional dividers, the index and ratio were calculated and plotted in groups. Fig. 3 shows a number of these collections. The

[4] The writer wishes to thank Dr. H. A. Pilsbry, of the Academy of Natural Sciences, for many courtesies.

probable error of the single *ratio* and *index* was calculated. These were based on twenty measurements of the three characters from a single shell.[5] The result of this was a probable error of ±.04 for

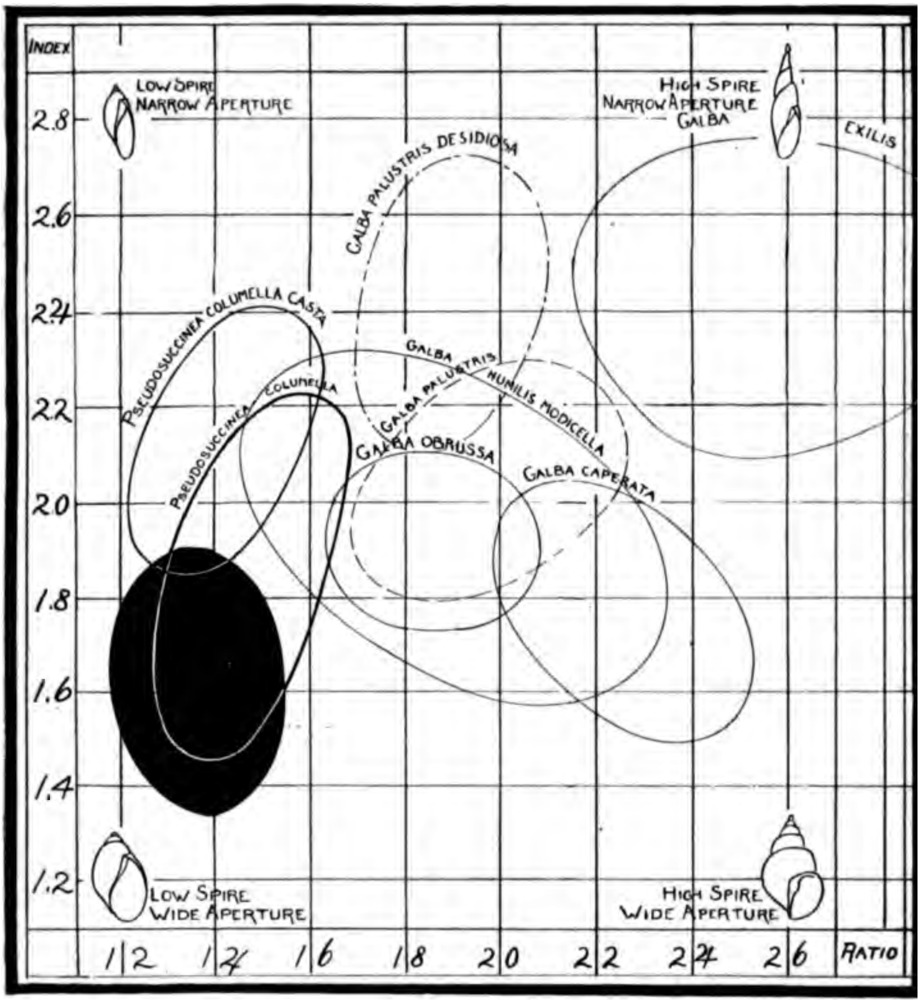

Fig. 2.

the *index* and ±.01 for the *ratio*. The probable error of the *index* was greater as this character was more difficult to measure. H. B.

[5] See Mellor (1905), pp. 515–520.

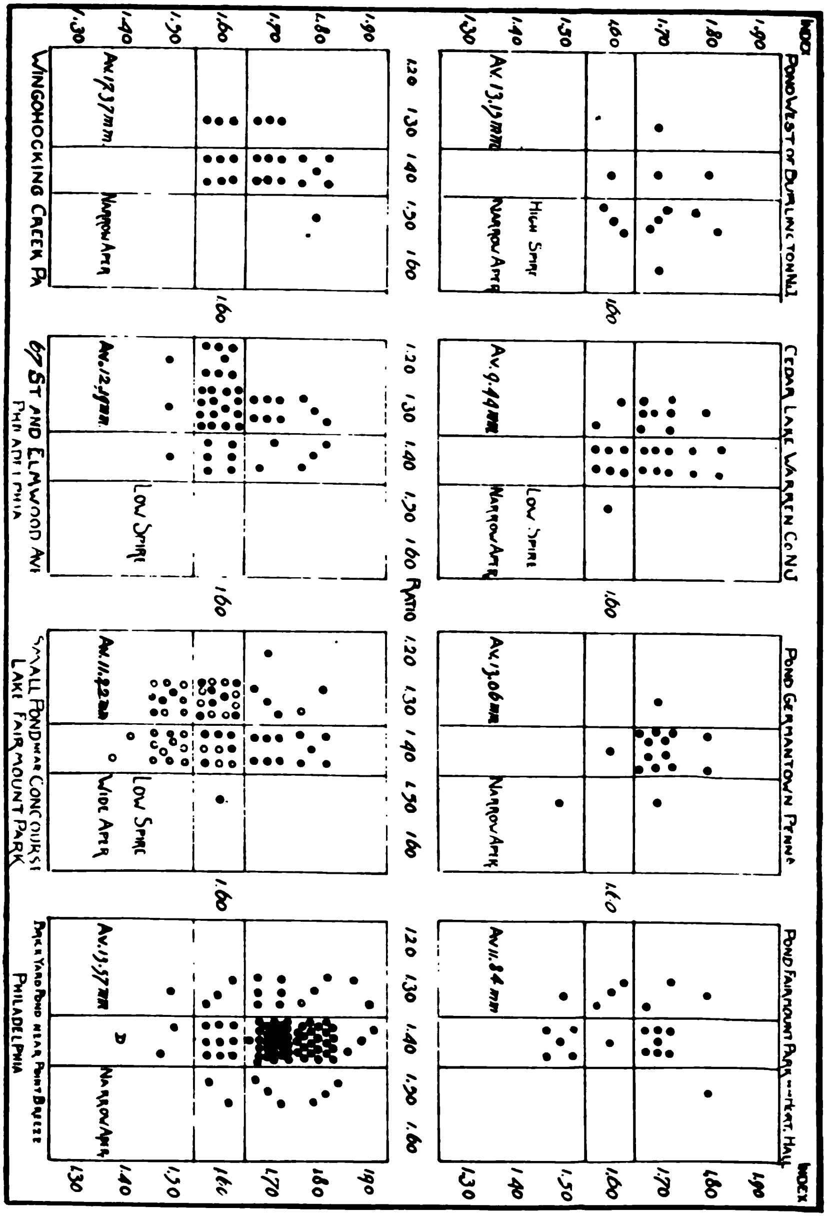

Fig. 3.

Baker (1910) found in *Lymnæa reflexa* that the length-breadth ratio of the shell increased with the length of the shell. That is, the larger shell had the higher ratio and therefore a higher spire. Tables I and II show this relationship in *Lymnæa columella* from about Philadelphia and on both tables the length in millimeters is the

TABLE I

INDEX	0–2	2–4	4–6	6–8	8–10	10–12	12–14	14–16	16–18	18–20	20–22 mm.	TOTAL 345
1.90							1	2	2			5
1.80					4	12	16	18	2	3		55
1.70			1	2	14	16	40	25	11	4	4	117
1.60		1	5	5	17	29	26	14	4	4	1	104
1.50		2	1		7	16	12	3				21
1.40		1				2						3
MEANS		1.500	1.600	1.629	1.633	1.627	1.664	1.709	1.721	1.691	1.680	1.654

TABLE II

RATIO	0–2	2–4	4–6	6–8	8–10	10–12	12–14	14–16	16–18	18–20	20–22 mm.	TOTAL 345
1.60							1					1
1.50		3	1			2	8	6	2			22
1.40		1	4	3	23	39	55	34	7	6	4	176
1.30				4	16	30	26	21	10	5	1	113
1.20					3	4	5	1				13
MEANS		1.475	1.420	1.343	1.348	1.352	1.373	1.373	1.358	1.345	1.380	1.362

ordinate. The *index* on Table I is the abscissa. On Table II the *ratio* is the abscissa. Table I shows that the larger shells have a narrower aperture, which agrees with H. B. Baker, but Table II shows that the height of the spire is about constant at all ages. On both tables no conclusions can be based on shells under eight millimeters, for two reasons: the numbers of shells are too small and the probable error of each ratio is too large. It may be as much as ±.10 on the part of the *index* and ±.05 for the *ratio*.

Remembering, then, that the larger shell may have a narrower aperture, then we may look over fig. 3. In this the Cedar Lake collection and the Wingohocking Creek collection both have narrow apertures, but the former has an average shell of 9.44 mm., while the latter has an average shell length of 17.37. The size of the shell cannot influence, then, the characters in question in this case. The other diagrams tell their own story and seem to show that each restricted area has its own type of shell as far as these two characters are concerned. The numbers are far too small on which to base many conclusions.

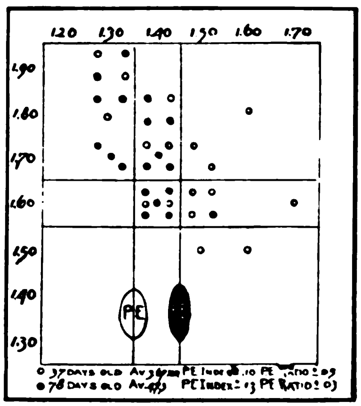

Fig. 4.

There were hatched during the past winter from an egg capsule laid by a snail from the Sixty-seventh Street and Elmwood Avenue collection thirty-two snails, of which eighteen lived to be measured. These were kept together in 1,000 cc. of water in a crystallizing dish. They were measured from time to time. From two of these measurements, an early one and a late one, 37 days and 78 days, respectively, fig. 4 was compiled.

The probable error of the individual 37 days old measurements,

which were made with the camera lucida, were *index* ±.10; *ratio* ±.05. These were so much larger in the case of the small shells because of the difficulty in orienting them in exactly the same plane at the time of measurement.

The range of the offspring are almost the same as that of the parent colony. This is only significant as showing what we may expect when we are able to deal with larger numbers in a more precise manner.

Baker (1911) observed copulation between different individuals of *Lymnæa stagnalis, Lymnæa emarginata* and *Lymnæa lanceata.* Several times *L. emarginata* tried to copulate with *L. lanceata,* a much smaller animal. Baker saw also *L. stagnalis* in copulation with *emarginata.* Heynemann (1869) records a cross between *auricularia* and *peregra,* the former acting as female and the latter as male. Chaster (1909) records a cross between *L. stagnalis* and *L. auricularia,* the former taking the part of the male. The progeny were good examples of *peregra,* and the query is raised by Chaster as to whether *peregra* may not be the ancestral form of *auricularia* and *stagnalis.* Be that as it may, it is possible that many of the so-called species and varieties of *Lymnæa* may be hybrids, and it will be necessary to experiment in order to determine how true this is. In the ponds about Philadelphia, however, where *Lymnæa columella* is found, the writer has never found any other species present. The chance of hybridization is, therefore, rare.

Conclusion.

Johannsen (1911) clearly defined the "pure line." "A pure line," he said, "may be defined as the descendants from one single homozygotic organism exclusively propagating by self-fertilization. . . . A line ceases to be 'pure' when hybridization (or even intercrossing) disturbs the continuity of the self-fertilization." With this definition in mind it is necessary, if we would have a pure line in the Johannsenian sense, to deal with hermaphroditic organisms. Not only must the organisms be hermaphroditic, but self-fertilization must be possible. It must either be normal or can be induced and controlled. These conditions can easily be fulfilled in many plants, but, as far as I am aware, no animals with the proper requirements have been experimented upon.

To be sure, Jennings (1911) and others have traced "lines" of Protozoa. These animals divide by fission so that their method of reproduction is probably closely allied to asexual or to parthenogenetic reproduction as found in multicellular forms.

The *Hydra* with which Handel (1907) worked reproduced by

budding. On the other hand, Woltereck's (1909) *Daphnia* were parthenogenetic. These "lines" of animals therefore cannot be compared strictly with those "lines" in plants that reproduce through self-fertilization.

Adhering strictly to Johannsen's definition, as far as I know no experiments with *pure lines* have ever been performed with animals.

Lymnæa, after this superficial study, would seem to furnish such material:

1. It apparently does self-fertilize its eggs when isolated.
2. The time for generation is short—two to three months.
3. There are a few well-defined characters that may be observed.
4. Hybridization is possible, but as far as *Lymnæa columella* from this region is concerned, it is rarely that more than one species is found in a single habitat. There is no evidence, as yet, that it is not homozygous.

On the whole, *Lymnæa columella* seems to combine some of the necessary requirements on which to base a pure-line investigation.

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A REVISION OF THE GENERA AND SPECIES OF THE GROUP MOGOPLISTII (ORTHOPTERA; GRYLLIDÆ) FOUND IN NORTH AMERICA NORTH OF THE ISTHMUS OF PANAMA.

BY JAMES A. G. REHN AND MORGAN HEBARD.

The group *Mogoplistii* forms a division of the subfamily *Myrmecophilinæ* and comprises eleven genera and over fifty species described from localities well distributed over the warmer regions of the earth. All of the species are of small size, very delicate and covered with minute, easily abraded scales, for which reasons they appear to have been but little collected, and in consequence most of the species were described from but little and often badly damaged material.

In studying an extensive series of North American specimens of this group, we found it necessary to go so deeply into the relationship of the various genera and species that it became incumbent on us to analyze all of the genera described to this date, to construct a new key for all of the genera, and also erect four new genera. In addition to this we were confronted with a great amount of confusion in regard to the characters and extent of certain genera and also some complicated specific synonymy. As these facts are best discussed in a chronological sequence, we have summarized the history of the names here treated.

History.

In 1839, Serville erected the genus *Mogoplistes*[1] on the species *M. brunneus* from southern Europe [Sardinia]. Guérin, in 1844, described the genus *Ornebius*,[2] basing it on two new species, *O. xanthopterus*, from Mauritius, and *O. nigripalpis*, from Pondicherry, the former of which has been selected as the genotype by Kirby. The same author, in 1849, erected the genus *Ectatoderus*,[3] on a new species *E. nigriventris*, from Abyssinia. In 1855, Costa based a new genus *Arachnocephalus*[4] on a species from Naples, this author being

[1] *Hist. Nat. Ins. Orth.*, p. 357.
[2] *Iconogr. Regne Anim.*, III, p. 331.
[3] In Lefebre, *Voy. en Abyss.*, VI, p. 336, Ins. pl. VI, fig. 3.
[4] *Fauna Nap.*, Grill., p. 41, pl. IX, fig. 5. We are unable to quote this reference from the original work as, unfortunately, our copy is incomplete, lacking among others the requisite page.

fully acquainted with *Mogoplistes*, with which he compared his new genus. Philippi, in 1863, described the genus *Microgryllus*[5] as a subgenus of *Gryllus*, placing in it the two new species *Gryllus pallipes* and *griseus* from Chili, to the former of which the name has since been limited. Scudder, in the year 1869, based a new genus *Cycloptilum*,[6] on a single new species, *C. squamosum*, from Texas, while at the same time he described another new species from Lower California as *Mogoplistes occidentalis*. Brunner, in 1873, proposed the name *Physoblemma*[7] for several unnamed species, which name is clearly shown by the text to be an exact equivalent of the older *Arachnocephalus* Costa, a genus apparently unknown to him at that time. Saussure, in 1874, described a new species from Cuba[8] which he referred to Scudder's genus *Cycloptilum* as *C. americanum*, later emending the spelling to *Cycloptilus*.[9] The same author, in 1877, erected the genus *Liphoplus*[10] for two new species, *L. novaræ* from Tahiti and *L. guerinianus* from an unknown locality, the former of which has been selected as type of the genus by Kirby. Bruner, in 1891, described a species as *Cycloptilum* (using Saussure's emended spelling, *Cycloptilus*) *borealis*, from Nebraska,[11] while the next year Redtenbacher described a species from St. Vincent, West Indies, which he called *Ectatoderus antillarum*.[12] Saussure, in 1897, in the *Biologia*[13] described two new species from Mexico as *Ectatoderus aztecus* and *Liphoplus mexicanus*, while in the same year Scudder described a species from southern Florida, based on a single female, as *Mogosiplistus* [emended *Mogoplistes*] *slossoni*.[14] In 1905, the present authors described a new species from a single male from southern Florida as *Liphoplus zebra*,[15] while Morse, in the same year, based a new species, *Mogisoplistus*[16] [emended *Mogoplistes*] *barbouri* on a single female from the Bahamas.

Classification.

The three facts which strike one most forcibly after a careful study of all the generic descriptions and the type species of the same are

[5] *Zeitschr. für Geo. Natur.*, XXI, p. 231.
[6] *Proc. Bost. Soc. Nat. Hist.*, XII, p. 142.
[7] *Schw. Entom. Gesell.*, IV, pp. 167, 169.
[8] *Miss. Sci. Mex., Rech. Zool.*, VI, p. 426, pl. 8, figs. 41, 42.
[9] *Mélang. Orth.*, II, p. 476, 1877.
[10] *Ibid.*, pp. 456, 483.
[11] *Canad. Ent.*, XXIII, p. 37.
[12] *Proc. Zoöl. Soc. London*, 1892, p. 218, pl. XVII, figs. 16*a*, 16*b*.
[13] *Biol. Centr. Amer., Orth.*, I, pp. 230–231.
[14] *Psyche*, VIII, p. 55.
[15] These Proceedings, 1905, p. 49, pl. I, fig. 12.
[16] *Psyche*, XII, p. 21.

first, that *Ectatoderus* is quite distinct from any North American form which has been referred to it. The greatly elongate pronotum of the male, covering by far the greater portion of the abdomen, is a character found in none of our species, while the form of the caudal metatarsus is quite distinctive. The second fact is that *Mogoplistes* is equally unrepresented in our fauna, the reference of forms from North America to this genus being due to the fact that no males were examined by the authors of those species. In all such cases we have examined the types and unquestionably identical males, these examinations proving that the species are not at all related to *Mogoplistes brunneus*, the type of that genus. The third fact is that "*Cycloptilus*" as understood by Saussure is not *Cycloptilum* Scudder, the characters of the pronotum, palpi and limbs being very different. This misinterpretation was doubtless due to a certain amount of vagueness in Scudder's original description, but much uncertainty as to what characters were really diagnostic of *Cycloptilum* resulted from Saussure's error. The latter's key to the genera of the group[17] contained two groups of very misleading characters; first, the division or non-division of the interantennal protuberance, and second, the elongate caudal metatarsus with its non-sulcate and non-serrate dorsum in "*Cycloptilus*." The former feature is of considerable value as a major section in a generic key, but as that vertical division is represented more or less clearly in a few genera by a sulcus, or in several by a decided deep incision, it is necessary to qualify the word "division." Saussure is completely in error in the characters which he gives for *Cycloptilum*, the typical material of the type of the genus being very different in these features.[18] The emphasis placed on these two sets of characters was responsible for the present authors describing *Liphoplus zebra* as a member of that genus, when it is really a *Cycloptilum*. The presence of a weak but apparent sulcus on the face, and the sulcate and serrate metatarsus easily ran the species into the genus *Liphoplus* as placed in Saussure's key.

Material Examined.—In the preparation of the present work the types of the following species have been before us:

Cryptoptilum hesperum n. sp.
(*Mogosiplistus slossoni* Scudder, synonym of *Cryptoptilum antillarum* Redtenbacher.)

[17] *Mélang. Orth.*, II, p. 456.

[18] Davis (*Jour. N. Y. Ent. Soc.*, XVII, p. 187, 1909) correctly analyzed the mistakes of previous authors and properly presented the evidence of the type of *Cycloptilum squamosum*.

(*Mogisoplistus barbouri* Morse, synonym of *Cryptoptilum antillarum* Redtenbacher.)
Cryptoptilum contectum n. sp.
Cryptoptilum tubulatum n. sp.
Cryptoptilum trigonipalpum n. sp.
Cycloptilum squamosum Scudder.
Cycloptilum zebra (Rehn and Hebard).
Oligacanthopus prograptus n. sp.
Hoplosphyrum occidentale (Scudder).
Hoplosphyrum boreale (Scudder).

The series examined numbers 763 specimens, generically distributed as follows: *Glaphyropus* 2, *Cryptoptilum* 475, *Cycloptilum* 236, *Oligacanthopus* 1, *Hoplosphyrum* 49. The great majority of these specimens were taken by the authors on recent trips and are located in the Hebard Collection and that of The Academy of Natural Sciences of Philadelphia, a considerable series, moreover, is in the Hebard Collection ex Bruner, while important specimens were kindly loaned to us by Dr. Samuel Henshaw, of the Museum of Comparative Zoology at Cambridge, and through Mr. A. N. Caudell we have been able to have before us the entire series of specimens belonging to the United States National Museum. To these gentlemen, for their many kindnesses, we wish to extend our hearty thanks. We would also express our gratitude to Professor Albert P. Morse, Mr. William T. Davis and Messrs. Sherman and Brimley for specimens of this group which they have sent us for examination.

Group MOGOPLISTII.

Group Characters.—Size of all forms small; body covered with translucent scales; apterous or having in the male sex abbreviate membranous tegmina. Head discoidal, depressed, having an interantennal protuberance which is separated from the vertex by a transverse sulcus; ocelli very small or absent; palpi variable in length. Pronotum in males often produced, vaulted or depressed; lateral lobes of pronotum very narrow. Tegmina when present containing all essential parts of tambourine. Caudal femora moderately or considerably inflated; caudal tibiæ serrulate on dorsal margins, without true spines, armed distad with six spurs; caudal metatarsi armed distad with two arcuate spurs; all of the internal spurs being longer than their external equivalents.

Key to the Genera of the Group.

A. Dorsum of metatarsus almost unarmed,[19]......GLAPHYROPUS n. gen.
(Genotype *G. americanus.*)

[19] In this division chætiform spines are apparent on the margins of the metatarsus when the latter is examined under a Zeiss binocular.

AA. Dorsum of metatarsus serrate or serrulate on margins.
B. Facial protuberance not markedly divided.
(OLIGACANTHOPUS[20] n. gen.)
(Genotype *O. prograptus.*)
C. Tegmina of male absent or only represented by rudiments.
D. Internal tibial spurs elongate, slenderer,
MICROGRYLLUS Philippi.
(Genotype *M. pallipes.*)
DD. Internal tibial spurs less elongate, more robust,
MOGOPLISTES Serville.
(Genotype *M. brunneus.*)
CC. Tegmina of male present, although frequently hidden under pronotum.
D. Pronotum of male very elongate, equal to two-thirds of body length. (Tegmina present, but completely covered by pronotum.)
ECTATODERUS Guérin.
(Genotype *E. nigriventris.*)
DD. Pronotum of male less elongate. (Tegmina partly visible or [*Cryptoptilum*] completely hidden under pronotum.)
E. Pronotum strongly narrowing cephalad in male, in length equal to about one-half that of body.
F. Tegmina of male not visible beyond pronotum. General size small,......CRYPTOPTILUM n. gen.
(Genotype *C. antillarum.*)
FF. Tegmina of male with periphery visible beyond pronotum. General size very small,
CYCLOPTILUM Scudder.
(Genotype *C. squamosum.*)
(OLIGACANTHOPUS n. gen., *vide supra.*)
EE. Pronotum not strongly narrowing cephalad in male, in general more or less subquadrate.
F. Tibial spurs very long. Ovipositor not at all enlarged at apex,......HOPLOSPHYRUM n. gen.
(Genotype *H. occidentale.*)
FF. Tibial spurs very short. Ovipositor somewhat enlarged at apex,...ORNEBIUS Guérin.
(Genotype *O. xanthopterus.*)
BB. Facial protuberance markedly divided.
C. Tegmina absent in both sexes. (No perforation of cephalic tibiæ.)..............................ARACHNOCEPHALUS Costa.
(Genotype *A. vestitus.*)

[20] This new genus belongs in this division, nearest *Cycloptilum*, but as it is known only from the female we are unable to place it more exactly in this key.

CC. Tegmina present in male, partly projecting beyond pronotum. (Cephalic face of cephalic tibiæ perforate.)
LIPHOPLUS Saussure.
(Genotype *L. novaræ*.)

GLAPHYROPUS[21] new genus.

1874. *Cycloptilum* Saussure (not of Scudder, 1868), Miss. Sci. Mex., Rech. Zool., VI, p. 425.
1877. *Cycloptilus* Saussure (not *Cycloptilum* Scudder, 1868), Mélang. Orth., II, p. 476.
1897. *Cycloptylum* Giglio-Tos (not *Cycloptilum* Scudder, 1868), Boll. Mus. Zool. Anat. Comp. Univ. Torino, XII, No. 301, p. 6.

The very elongate caudal metatarsus which is very sparsely and very delicately armed dorsad, will immediately separate this genus from the other genera of the group. Under an ordinary hand lens the metatarsus appears unarmed dorsad, and this is doubtless the reason Saussure accentuated this character, thus differentiating it from the allied genera, but under a moderate-power microscope the margins are seen to be supplied with delicate chætiform spines. However, this spination is most subtle and is entirely different in character from that found in any of the allied genera, which all have these spines more decidedly dentiform, often contrastingly colored and always truly serrate in their arrangement. The extremely slender metatarsus is so striking a character that it will at once serve to distinguish members of this genus.

Genus monotypic. GENOTYPE—*Glaphyropus americanus* [*Cycloptilum americanum*] (Saussure).

Generic Description.—Head small, subelongate, smooth; interantennal protuberance weak, broadly rounded, no vertical dividing sulcus present; eyes pyriform, not inflated; maxillary palpi very long and slender, the distal joint very obliquely truncate, labial palpi short. Pronotum of male strongly produced caudad covering the base of the abdomen, caudal margin strongly arcuate; of female subquadrate in form, cephalic margin truncate, caudal margin weakly arcuate and covering mesonotum and base of metanotum. Tegmina in male concealed by the pronotum, absent in female. Ovipositor straight, slender, moderately long; distal valves lanceolate, but not differentiated from the shaft. Supra-anal plate of male strongly plicate, bicarinate, bimammilate at the base; of female rotundato-trigonal, sulcate cephalo-caudad and folded between the cerci. Subgenital plate trapeziform in male; rotundato-trigonal

[21] From γλαφυρός, smooth, and πούς, foot; in allusion to the practically unarmed dorsal margins of the caudal metatarsus.

in female. Cerci very long and slender, very smooth, tapering. Caudal femora dilated; caudal tibiæ slender, subcompressed, very finely serrulate on dorsal margins, with three pair of distal spurs, the dorso- and ventro-internal subequal, the mediointernal nearly twice their length and equal to about two-fifths the length of the metatarsus; caudal metatarsus very elongate, slender, equal to over half the length of the caudal tibia, dorsal margins supplied with very delicate chætiform spines, second joint minute, third joint very small.

Distribution in North America.—Cuba, Vera Cruz, Lower California and Mexico.

Glaphyropus americanus (Saussure).

1874. *Cycloptilum americanum* Saussure, Miss. Sci. Mex., Rech. Zool., VI, p. 426, pl. 8, figs. 41, 42. [Cuba.]

1874. *Cycloptilum poeyi* Saussure, *ibid.*, explanat. pl. 8, figs. 41, 42. (Plate name only.)

1888. *C[ycloptilum] americanum* Bolivar, Mem. Soc. Zool. France, I, p. 157. [Cuba.]

1891. *Cycloptilus americanus* Gundlach, Entom. Cuban. II, p. 370. [Cuba.]

1909. *Cycloptilum americanum* Rehn, Second Rept. Cent. Exp. Sta., Cuba, p. 221. [Cuba.]

TYPES: ♂ and ♀; Cuba. (Poey and Gundlach.) [Saussure Collection.]

The following description is based upon a female from San Rafael, Vera Cruz, Mexico. (Townsend.) [Hebard Collection.]

Size small; form subdepressed; surface very smooth.[22] Head ovoid, subdepressed, but convex dorsad; interantennal protuberance separated from the vertex by a well-marked transverse interantennal

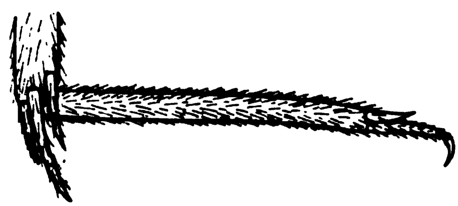


Fig. 1.—*Glaphyropus americanus.* Internal face of caudal metatarsus and internal tibial spurs. (Greatly magnified.)

sulcus. Maxillary palpi greatly elongate, distal joint elongate tubiform, distal margin very obliquely truncate. Pronotum transversely strongly arcuate, caudal width subequal to the length, lateral outlines of disk gently arcuate, expanding little caudad;

[22] Scales completely abraded from the only specimen seen by us.

lateral lobes broadly passing into disk except caudad where there is a slight angle, depth of lobes about one-third the greatest length, ventral margin truncate, obliquely truncate caudad. Subgenital plate arcuato-trigonal, subcompressed; ovipositor shorter than the caudal femora, slightly thickened proximad, subequal and quite slender for the greater portion of its length, apex not broadened, lanceolate, dorsal valves at apex with four rows of punctæ which are evenly spaced so that these valves when seen from certain angles appear to have their margins subcrenulate, ventral valves smooth. Cephalic and median limbs slender, femora subcompressed; cephalic tibiæ with a very minute tympanum placed more toward the dorsal face of the tibiæ than is usually the case. Caudal tibiæ slightly arcuate ventrad, the medio-external spur nearly twice the length of the dorso-external spur and considerably longer than the ventro-external one, all of the external spurs shorter than the internal. Caudal metatarsus slightly arcuate dorsad, subcompressed, with distal spurs small, slender, subequal, reaching to the base of the distal tarsal joint.

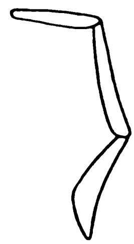


Fig. 2.—*Glaphyropus americanus.* Maxillary palpus. (Greatly magnified.)

Description of Male.[22]—This sex differs from the female in the following characters. Pronotum much larger, strongly produced caudad as far as the second or third abdominal segment, expanding gradually caudad, caudal margin broadly semicircular. Tegmina large, rounded, not reaching quite as far as the caudal margin of the pronotum, entirely covered by the same. Subgenital plate trapeziform, convex, punctate, margin sub-bilobate.

Measurements (in millimeters).

	Cuba (ex Saussure).		San Rafael, Vera Cruz, Mexico.	San José del Cabo, Lower California.
	♂	♀	♀	♀
Length of body	5.5	5.6	5.7	6.7
Length of pronotum	3	1.8	1.7	2
Caudal width of pronotum	2.4	2	1.7	2
Length of caudal femur	3.8	4	4	4
Greatest width of caudal femur	......	......	1.5	1.5
Length of ovipositor	......	2.8	2.8	2.8

Color Notes.—Saussure says of the species "pallid fulvo-testaceus,

[22] Amplified from Saussure, his figure showing several characters not mentioned in his description.

holosericeo-tomentose, head and thorax fulvous, abdomen more grayish." The specimen before us from Lower California has been dried from alcohol, and in consequence its coloration is greatly altered from that of nature. In general it is cream-buff, darkening to ochraceous on the head, antennæ, thorax and base of the abdomen, eyes dark slate-gray, ovipositor pale ochraceous with the apex tawny. The specimen in our possession from the state of Vera Cruz is cinnamon, darkening to vandyke-brown on the sides of the head, pronotum and dorsal surface of the abdomen, eyes vandyke-brown, underparts of body, palpi, cephalic and median limbs and caudal tarsi clay color, ovipositor russet.

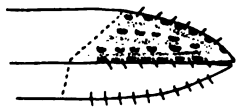


Fig. 3.—*Glaphyropus americanus.* Apex of ovipositor. (Greatly magnified.)

Distribution.—Only known from Cuba, the state of Vera Cruz, Mexico, the extremity of Lower California (San José del Cabo) and northern Venezuela.[24] It is possible that the Venezuelan material may not be identical.

Synonymy.—Saussure's erroneous association of this very distinct generic group with *Cycloptilum* Scudder beclouded the characters of true *Cycloptilum*, preventing some authors from recognizing the latter, as Scudder failed to mention the character of the dorsal margins of the caudal metatarsus.

Remarks.—We have before us two females of this species from Mexican territory, which show no character of difference from the original description—in fact, agreeing in every particular. It is interesting to find material from such widely separated and different localities agreeing so thoroughly.

Specimens Examined.—2 females.

San Rafael, Vera Cruz, Mexico; 1 ♀. [Hebard Collection.]
San José del Cabo, Lower California; 1 ♀. [Hebard Collection.]

CRYPTOPTILUM[25] new genus.

1892. *Ectatoderus* Redtenbacher (not of Guérin, 1849), Proc. Zoöl. Soc. London, 1892, p. 218.
1897. *Liphoplus* Saussure, Biol. Cent. Amer., Orth., I, p. 232 (in part).
1897. *Mogosiplistus* Scudder (not *Mogoplistes* Serville, 1839), Psyche, VIII, p. 55.
1897. *Mogosiplistus* Scudder (not *Mogoplistes* Serville, 1839), Guide to Gen. Class. N. Amer. Orth., p. 63.
1905. *Mogisoplistus* Morse (not *Mogoplistes* Serville, 1839), Psyche, XII, p. 21.

[24] Giglio-Tos, *Boll. Mus. Zool. Anat. Comp. Univ. Torino*, XII, No. 301, p. 6. 1897.

[25] From κρυπτόν, hidden, and πτίλον, wing; in allusion to the hidden tegmina.

1905. *Cycloptilus* Morse (not *Cycloptilum* Scudder, 1868), Psyche, XII, p. 21.
1905. *Liphoplus* Rehn and Hebard (not of Saussure, 1877), Proc. Acad. Nat. Sci. Phila., 1905, p. 49.
1906. *Liphoplus* Rehn (not of Saussure, 1877), Bull. Amer. Mus. Nat. Hist., XXII, p. 117.
1907. *Liphoplus* Rehn and Hebard (not of Saussure, 1877), Proc. Acad. Nat. Sci. Phila., 1907, p. 316.
1909. *Liphoplus* Rehn (not of Saussure, 1877), Second Rept., Cent. Exp. Sta. Cuba, p. 220.
1910. *Liphoplus* Rehn (not of Saussure, 1877), Proc. Acad. Nat. Sci. Phila., 1910, p. 10.
1911. *Cycloptilus* Sherman and Brimley, Ent. News, XXII, p. 391 (in part).

Genus includes five species. GENOTYPE.—*Cryptoptilum antillarum* [*Ectatoderus antillarum*] (Redtenbacher).

Generic Description.—Form depressed, compact, surface clothed with scales; pronotum produced caudad in male; tegmina absent in female, concealed by pronotum in male.

Head small, rounded, produced cephalad; interantennal protuberance with trace of vertical division. Pronotum of male narrow cephalad, produced caudad, in length equal to about half of the entire length of the body; of female sub-quadrate. Tegmina of male concealed by disk of pronotum, tympanum perfectly developed, caudal margin of dorsal field of tegmina strongly arcuate; lateral field of tegmina well developed. Ovipositor nearly straight, narrowly sub-lanceolate at apex, the latter with margins unarmed. Subgenital plate of female with distal margin complete or angulate-emarginate mesad. Cerci of both sexes elongate, tapering. Cephalic tibiæ with the cephalic face bearing a distinct tympanum. Caudal femora much dilated; armament of limbs as in *Cycloptilum*.

Distribution in North America.—Extending from central North Carolina southward to extreme southern Florida and westward to Brazos County, Texas. The genus is also found in Lower California and has a wide insular distribution, having been recorded from Bermuda, the Bahamas, Cuba and St. Vincent.

Key to Cryptoptilum, New Genus.

A. Terminal joint of maxillary palpi moderately elongate, expanding gently distad, gently obliquely truncate.
  B. Pronotum of male widening gradually but distinctly caudad.
    C. Pronotum of male with cephalic width contained about two and three-quarters times in the greatest length of the same, much produced caudad; subgenital plate of female broadly truncate distad with no emargination . . . . *hesperum* n. sp.

CC. Pronotum of male with cephalic width contained hardly twice in the greatest length of the same, not as much produced caudad; subgenital plate of female arcuato-convergent, narrowly acute-angulate emarginate distad........*antillarum* (Redtenbacher).

BB. Pronotum of male subequal in width........*tubulatum* n. sp.

AA. Terminal joint of maxillary palpi not so elongate, expanding widely distad, very obliquely truncate.

B. Form compact, pronotum of male widening gradually, but broadly caudad, not constricted in either sex; subgenital plate of female arcuato-convergent, carinate meso-caudad, very narrowly acute-angulate emarginate distad, *contectum* n. sp.

BB. Form rather slender, pronotum of male narrow, expanding gently caudad, noticeably constricted in both sexes; subgenital plate of female arcuato-convergent, broadly obtuse-angulate emarginate distad......*trigonipalpum* n. sp.

Cryptoptilum hesperum n. sp.

This species is closely related to *C. antillarum*, but differs from it in having the interantennal protuberance more produced and bulbous, the joints of the maxillary palpi more elongate with the terminal joint more roundly and less obliquely truncate. The pronotum is heavier in both sexes, and considerably longer proportionately in the male. The caudal tibiæ and metatarsi are very slightly longer in proportion to the length of the caudal femora, the caudal metatarsi having normally on each dorsal margin ten or more serrations. In the male the subgenital plate is much as in *antillarum*, but in the female it is gently arcuato-convergent laterad, broadly arcuato-truncate distad with no trace of emargination.

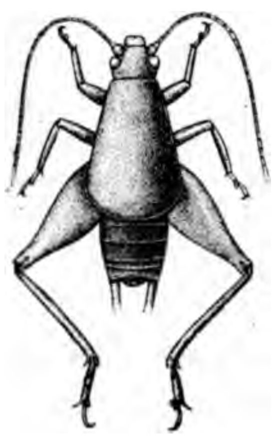


Fig. 4.—*Cryptoptilum hesperum*. Dorsal view of allotype. (× 4.)

TYPE: ♀; San Lazaro, Lower California, September, 1894. [Hebard Collection.]

Description of Type.—Size medium for group. Head small, interantennal protuberance much produced and bulbous, much longer in proportion to the general size of the head than in *antillarum*, divided vertically by a very minute sulcus. Maxillary palpi with penultimate joint about two-thirds as long as terminal joint, the latter expanding very gently

distad, very mildly obliquely truncate. All of the joints of the maxillary palpi are considerably longer and more attenuate than in *antillarum*. Eyes much as in *antillarum*, pronotum likewise, but heavier. Tegmina absent. Subgenital plate somewhat arcuato-convergent laterad, broadly truncate distad with no emargination whatever. Ovipositor as in *antillarum*. Cerci missing. Cephalic tibiæ with cephalic face bearing a distinct tympanum. Armament of limbs much as in *antillarum* except that the serrations on the dorsal margins of the caudal metatarsi are heavier and less widely spaced, and number seven on inner, ten on outer margin. Caudal tibiæ and metatarsi very slightly longer proportionally than in *antillarum*.

Allotypic ♂: Lower California. [Hebard Collection.]

Description of Allotype.—Slightly smaller than female. Pronotum larger and proportions considerably longer than in *antillarum*, the caudal margin transverse, broadly arcuate. Tegmina much as in *antillarum*.

In addition to the type and allotype, the entire series of specimens here examined and listed below may be considered paratypic.

Measurements (in millimeters).

	ALLOTYPE. Lower California.	TYPE. San Lazaro, L. Cal.	San José del Cabo, L. Cal.
	♂	♀	♀
Length of body	8	8.9	10
Length of pronotum	5.1	2.7	2.9
Caudal width of pronotum	3.1	2.7	3
Length of caudal femur	5.4	5.4	.....
Greatest width of caudal femur	2	2	.....
Length of caudal tibia	3.9	4	.....
Length of caudal metatarsus	1.6	1.7	.....
Length of ovipositor	.....	5	6.6

Color Notes.—As all but the two adult females are dried alcoholic specimens, our color notes refer to these two specimens only. In ground coloration they are much like *antillarum*, but the dorsum of the abdomen is wholly black. The scaly covering of the type is in perfect condition, and shows the insect to be thickly covered with scales as in *antillarum*, but in this case the scales are metallic-bronze in color. In this specimen there is a cephalic bar of dark brown which crosses the eye, but is not continued on the pronotum; in the two other adult specimens, both of which have almost entirely lost

their scaly covering, no trace of such a bar exists. The maxillary palpi are dark brown and are covered with light hairs.

Distribution.—The known range of this species is confined to Lower California.

Remarks.—As noted under *antillarum*, the female, in the later stages of the nymphal condition, has dentiform spines on each side of the ovipositor sheath; these are situated distad along the ventral margin of the upper section of the valves, and in the specimen before us are five in number on each side. The adults all have a distinct tympanum on the cephalic face of the cephalic tibiæ, but this tympanum is not present in any of the nymphs.

Specimens Examined.[26]—10; 1 male, 2 females and 7 nymphs.

Lower California; 1♂, 1♀ n.
Sierrá el Toste, L. Cal.; September 23, 1894; (Eisen); 1♂n, 1♀n.
San Lazaro, L. Cal.; September, 1894; 1♀, 2♂n, 2♀n. (♀ TYPE.)
San José del Cabo, L. Cal.; 1♀.

Cryptoptilum antillarum (Redtenbacher).

1892. *E[ctatoderus] antillarum* Redtenbacher, Proc. Zoöl. Soc. London, 1892, p. 218, pl. XVII, figs., 16a, 16b. [St. Vincent, West Indies.]
1897. *Liphoplus krugii* Saussure, Biol. Cent. Amer., Orth., I, p. 232. [Cuba.] (March, 1897.)
1897. *M[ogosiplistus] slossoni* Scudder, Psyche, VIII, p. 55. [Biscayne Bay, Florida.] (April, 1897.)
1905. *Liphoplus krugii* Rehn and Hebard, Proc. Acad. Nat. Sci. Phila., 1905, p. 49. [Key West, Florida.]
1905. *Mogisoplistus barbouri* Morse, Psyche, XII, p. 21. [Nassau, New Providence Island, Bahamas.]
1906. *Liphoplus krugii* Rehn, Bull. Amer. Mus. Nat. Hist., XXII, p. 117. [Mangrove Key, Andros, and Pot Key, Andros, Bahamas.]
1907. *Liphoplus krugii* Rehn and Hebard, Proc. Acad. Nat. Sci. Phila., 1907, p. 316 (in part). [Pablo Beach and Gainesville, Florida.]
1909. *Liphoplus krugii* Rehn, Second Rept., Cent. Exp. Sta. Cuba, p. 220. [Cabañas Fortress, Cuba.]
1910. *Liphoplus krugii* Rehn, Proc. Acad. Nat. Sci. Phila., 1910, p. 10. [Paget West, Bermuda.]
1911. *Cycloptilus squamosus* Sherman and Brimley (not of Scudder, 1868), Ent. News, XXII, p. 391 (in part). [Beaufort, North Carolina.]

TYPE: ♂, and allotype, ♀; St. Vincent, West Indies, windward side. (H. H. Smith.) [British Museum.]

The following description is based upon a male from Wrightsville, North Carolina, September 7, 1911. (Rehn and Hebard.) [Hebard Collection.]

Size medium for the group, head small, interantennal space roundly

[26] The entire series is in the Hebard Collection.

produced and divided by a very minute subobsolete longitudinal sulcus. Maxillary palpi with penultimate joint about two-thirds as long as terminal joint, the latter expanding gently distad, gently obliquely truncate. All of the palpal joints proportionately more attenuate than in the two known species of the genus *Cycloptilum*. Eyes pyriform, s u b v e r t i c a l.. Pronotum narrowing regularly cephalad, considerably produced caudad, the entire dorsal surface transversely gently arcuate; the caudal margin transverse, broadly arcuate. Tegmina wholly concealed from above by the pronotum, from the side the lateral field may be seen to embrace the abdomen. Cerci as long as the abdomen. Cephalic tibiæ with cephalic face bearing a large, oval and distinct tympanum. C a u d a l femora dilated. Caudal tibiæ with three pair of well-developed distal spurs, the dorso-internal noticeably shorter than the ventro-internal spur, the medio-internal spur considerably longer than the others with its length contained about twice in the metatarsus. Caudal metatarsus rather long, straight, rather broad, sulcate dorsad, both dorsal margins armed with four and five on inner and six and seven well-developed serrations[27] on outer margins, the distal extremity armed on both sides with a long spur, the longer inner spur reaching to the end of the first third of the terminal tarsal joint.

Fig. 5.—*Cryptoptilum antillarum*. Dorsal view of male specimen here described. (× 4.)

Fig. 6. — *Cryptoptilum antillarum*. Internal face of caudal metatarsus and tibial spurs. (Greatly magnified.)

A female, taken with the male here described, differs from it in the following respects:

Larger; the pronotum subquadrate, narrowing very little cephalad; tegmina absent. The subgenital

[27] The number of these serrations is found to vary considerably in the species of this group, but the inner margins always bear fewer serrations than the outer margins in the same individual.

plate is arcuto-convergent laterad, semi-ovate, narrowly acute-angulate emarginate at the apex. The ovipositor is long, straight, lateral division of valves exactly at middle of the sides, sub-lanceolate at apex, the latter with margins unarmed.

Measurements (in millimeters).

	Wrightsville, N. C. Described.[28] ♂	Wrightsville, N. C. Described.[28] ♀	Wrightsville, N. C. Average of series. ♂♂	Wrightsville, N. C. Average of series. ♀♀
Length of body	9.	9.3	8.2(7.2–9.)	8.8(8. –9.8)
Length of pronotum	4.	2.5	4. (3.8–4.2)	2.3(2.2–2.5)
Caudal width of pronotum	3.	2.8	3. (2.8–3.1)	2.5(2.3–2.9)
Length of caudal femur	5.5	6.	5.1(4.5–5.5)	5.7(5.1–6.)
Width of caudal femur	2.	1.9	1.9(1.5–2.1)	1.9(1.8–2.)
Length of ovipositor	......	5.5	....	5.2(4.9–5.5)

	Isle of Hope, Ga. Average of series. ♂♂	Isle of Hope, Ga. Average of series. ♀♀
Length of body	7.8(7.6–8.1)	8.4(7. –9.)
Length of pronotum	4. (3.9–4.2)	2.2(2. –2.4)
Caudal width of pronotum	2.7(2.5–2.9)	2.4(2.1–2.7)
Length of caudal femur	4.9(4.5–5.)	5.6(5. –6.)
Width of caudal femur	1.7(1.6–1.9)	1.9(1.7–2.)
Length of ovipositor	....	5.1(4.8–5.6)

	Atlantic Beach, Fla. Average of series. ♂♂	Atlantic Beach, Fla. Average of series. ♀♀
Length of body	7.6(7.4–8.)	8. (7.5–8.5)
Length of pronotum	4. (3.8–4.1)	2.2(2. –2.7)
Caudal width of pronotum	2.8(2.7–3.)	2.5(2.3–2.8)
Length of caudal femur	4.9(4.3–5.2)	5.5(5. –6.2)
Width of caudal femur	1.8(1.7–2.)	1.9(1.8–2.2)
Length of ovipositor	....	5.1(4.6–5.4)

	Key West, Fla. Average of series. ♂♂	Key West, Fla. Average of series. ♀♀
Length of body	6.9 (6.7–7.3)	7.1(6.5–8.)
Length of pronotum	4. (3.8–4.2)	2.1(2. –2.2)
Caudal width of pronotum	2.85(2.8–3.)	2.2(2.1–2.4)
Length of caudal femur	4.3 (4.1–4.5)	5. (4.9–5.2)
Width of caudal femur	1.6 (1.5–1.7)	1.9(1.8–2.)
Length of ovipositor	....	4.2(4. –4.3)

[28] These measurements are almost exactly the same as those given by Redtenbacher in his original description. The large size of St. Vincent specimens may prove to be the result of tropical influence.

These measurements plainly show that, in the United States, the species reaches its greatest size at the northern limit of its range, and that it gradually and constantly decreases in size southward, although in all of the large series from a single locality there exists a great amount of size variation. Specimens from Cabañas, Cuba, are very much like those from Key West.

Color Notes.—Ground color of dorsal surface of pronotum, head, mesonotum, metanotum, and sometimes first abdominal segments, russet, in some individuals varying to mars-brown. In the majority of specimens, sides and under portions of head, lateral lobes of pronotum, all of the limbs and under portions of body excepting abdomen are of a much lighter shade, the outer and dorsal faces of

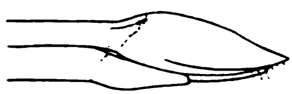


Fig. 7.—*Cryptoptilum antillarum.* Apex of ovipositor. (Greatly magnified.)

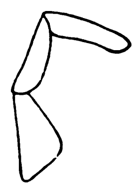


Fig. 8.—*Cryptoptilum antillarum.* Maxillary palpus. (Greatly magnified.)

caudal femora often dark. Abdomen black, frequently marked above on edges of segments with brown, this usually more pronounced in female sex, and females are occasionally found with whole dorsum of abdomen suffused with that color. Maxillary palpi usually color of under portions of body, sometimes darkly suffused toward distal extremity of last segment.

Specimens covered with scales usually appear wholly silvery-drab or silvery-white, as all portions of the insect excepting the eyes, face and feet are heavily scaled. Specimens frequently have these scales rubbed off in such a way that the insect would at first glance appear to belong to a distinct species. An inconspicuous dark post-ocular bar is often to be found on the head in the present species, but is never continued on the pronotum.

Distribution.—In the United States this species is found within the boundaries of the Lower Austral Zone; the most northern locality at which it has been taken is Beaufort, on the central portion of the coast of North Carolina, and the vicinity of Wilmington on the southern coast of that State. A specimen before us from Brazos County, Texas, constitutes the most western record at the present date. The species is found on the Bermudas, and is probably widely

distributed through the greater and lesser Antilles, having been taken in the Bahamas, Cuba, and St. Vincent.

Biological Notes.—The present species is bush-loving, and over the greater portion of its range is rather plentiful in bayberry and other heavy bushes. On the Florida Keys, specimens could almost invariably be found in *Ilex cassine* during the proper season. At Wrightsville, North Carolina, not only was it found in great numbers in the bayberry bushes, but also on the ground among leaves and low plants under live oaks in countless numbers. Hardly ever before had the species been found on the ground. In this respect the present species differs from both known species of *Cycloptilum* which are almost wholly terrestrial, and it may be said to be truly thamnophilous.

Synonymy.—The description and figures of *antillarum* perfectly match the series of specimens before us, and we unhesitatingly refer our specimens to Redtenbacher's species.

Saussure's *Liphoplus krugii* from Cuba also agrees perfectly, and specimens before us from Cuba which we have previously determined as *krugii* are inseparable from others in the present series. The name consequently falls into the synonymy under *antillarum.*

Scudder has described *Mogosiplistus slossoni* from Biscayne Bay, Florida, apparently without reference to the literature bearing on the *Mogoplistii* of the Antilles, and after examination of his type we unhesitatingly place it also in the synonymy under *antillarum.*

We have examined the unique female type of *Mogisoplistus barbouri* Morse, in the Museum of Comparative Zoology at Cambridge, and find it to be a very large specimen of the present species, ten millimeters in length. The tympanum on the cephalic face of the cephalic femora in *antillarum* is found to vary in a large series from elliptical to nearly circular, and the fact that the species in southern Florida is particularly small, doubtless caused the large Bahaman specimen to appear different from the small individuals of the type series of Scudder's synonymic *Mogosiplistus slossoni* when it was compared with those specimens and described as new.

Remarks.—The female of this species in the later stages of the nymphal condition has six heavy dentiform spines on each side of the heavy ovipositor sheath, these are situated distad along the ventral margin of the upper sections of the valves.

Specimens Examined.—438; 175 males, 216 females and 47 nymphs.

Beaufort, N. C.; early July, 1909; (Sherman); 2 n.: middle Sept., 1911; 1♂, 1♀. [Coll. N. C. Dept. Agr.]

Wrightsville, N. C.; Sept. 7, 1911; (R. and H.)[29]; 91 ♂, 125 ♀, 6 ♀ n.

Winter Park, N. C.; Sept. 7, 1911; (R. and H.); 3 ♂, 9 ♀, 1 ♀ n.

Lake Waccamaw, N. C.; Sept. 8, 1911; (R. and H.); 2 ♂.

Florence, S. C.; Sept. 6, 1911; (R. and H.); 1 ♂, 1 ♀ n.

Sullivan Id., Charleston Co., N. C.; Sept. 5, 1911; (R. and H.); 1 ♂.

Tybee Id., Ga.; Sept. 2, 1911; (H.); 1 ♀.

Isle of Hope, Ga.; Sept. 3, 1911; (R. and H.); 27 ♂, 36 ♀, 5 ♀ n.

St. Simon's Id., Ga.; Aug. 30, 1911; (R.); 2 ♂, 2 ♀.

Cumberland Id., Ga.; Aug. 31, 1911; (R. and H.); 1 ♂, 2 ♀, 4 ♀ n.

Jacksonville, Fla.; (Pridday); 1 ♀, 1 ♀ n. [Hebard Collection.]

St. George, Fla.; Aug. 27, 1882; 1 ♂. [Hebard Collection.]

Atlantic Beach, Fla.; Aug. 24, 25, 1911; (R. and H.); 13 ♂, 11 ♀, 3 ♀ n.

Pablo Beach, Fla.; Aug. 12, 13, 1905; (R. and H.); 2 ♂, 1 ♀ n.

Gainesville, Fla.; Aug. 16, 1905; (R. and H.); 1 ♀.

Lake Worth, Fla.; (Slosson); 1 n. [Scudder Collection.]

Biscayne Bay (Miami), Fla.; Feb. 9, 1904; (H.); 1 ♂: (Slosson); 1 ♂, 1 ♀,[30] 1 n. [Scudder Collection.]; Nov. 18, 1911; (Englehardt), 1 ♂. [W. T. Davis Collection.]

Key Largo, Fla.; March 18, 1910; (H.); 1 ♀ n.

Long Key, Fla.; March 13, 1910; (H.); 7 ♂, 5 ♀, 2 ♂ n, 2 ♀ n.

Key Vaca, Fla.; March 14, 1910; (H.); 3 ♂, 3 ♂ n, 1 ♀ n.

Boot Key, Fla.; March 14, 1910; (H.); 1 ♂.

Key West, Fla.; Jan. 19, 1904; (H.); 1 ♂, 2 ♀, 4 ♀ n: March 15, 16, 1910; (H.); 9 ♂, 13 ♀, 3 ♂ n, 4 ♀ n.

Wellborn, Brazos Co., Tex.; Aug. 27, 1904; 1 ♀. [U. S. N. M.]

Paget West, Bermuda; Jan. 6, 18, 1909; (F. M. Jones); 4 ♀. [A. N. S. P.]

Nassau, New Providence Island, Bahamas; July, 1904; (T. Barbour); 1 ♀. (TYPE of *Mogisoplistus barbouri* Morse) [Mus. Comp. Zool.]

Cabañas (Fortress), Cuba; Jan. 29, 1904; (H.); 5 ♂, 1 ♀, 1 ♀ n.

Cryptoptilum tubulatum[31] n. sp.

This species is quite different from *C. antillarum*, to which of the known species of this genus it is most nearly related. Its form is quite distinctive owing to its somewhat tubular appearance, caused by the fact that in this species alone, of the six known to belong to the genus *Cryptoptilum*, the head, pronotum and abdomen are of very

[29] Throughout the present paper it is understood that specimens taken by the authors are in the Hebard Collection and The Academy of Natural Sciences of Philadelphia.

[30] This female is the type, here selected, of *Mogosiplistus slossoni* Scudder; the other specimens, male and nymph, are paratypes.

[31] In allusion to the tubular appearance of the insect.

nearly the same width throughout. The insect is very much the same size as *antillarum*, but the dorsal surface of the head is more flattened, while the interantennal protuberance is more sharply rectangulate. As in *C. trigonipalpum*, the tympanum on the cephalic face of the cephalic tibia is circular, not oval as is usual in *C. antillarum*. The last three segments of the maxillary palpi are much as in *antillarum*, but are more robust in proportion to their length. The pronotum is proportionally longer and its sides are subparallel. The caudal femora are much the same as in *antillarum*, and the armament of the limbs is similar.

TYPE: ♂; Salina Cruz, Oaxaca, Mexico; December 22, 1898. [Hebard Collection.]

Description of Type.—Size medium for the group. Head small, interantennal space produced and sharply rounded, divided by a very minute subobsolete longitudinal sulcus. Maxillary palpi with fourth joint from distal extremity nearly twice as long as broad, considerably longer than in *C. antillarum*. Eyes pyriform, subvertical, somewhat larger and slightly more prominent than in *antillarum*. Pronotum when seen from above subequal in width, considerably produced caudad, the entire dorsal surface transversely gently arcuate, more decidedly so than in *antillarum*, the caudal margin subtruncate. Tegmina wholly concealed dorsad by the pronotum, a portion of the lateral field may be seen to embrace the abdomen, though in this species the peculiar shape of the pronotum causes the lateral lobes to embrace the sides of the body to nearly the caudal margin of the pronotum. Cephalic tibiæ with cephalic face bearing a large, circular and distinct tympanum. Limbs, and armament of the same, much as in *antillarum*.

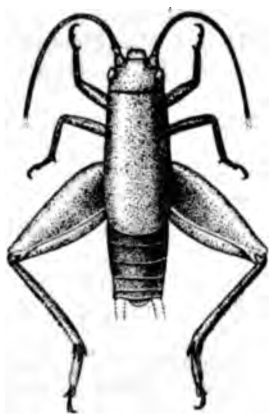


Fig. 9.—*Cryptoptilum tubulatum*. Dorsal view of type. (× 4.)

Measurements (in millimeters).—♂: Length of body, 8.2; length of pronotum, 5.2; cephalic width of pronotum, 2; caudal width of pronotum, 2.1; length of caudal femur, 5.3; width of caudal femur, 1.8.

Color Notes.—Ground color of dorsal surface of pronotum russet. Dorsal surface of head and all of abdomen blackish-brown. Other

portions of head including palpi and also limbs very dark bistre. Antennæ tawny-olive. The body is heavily scaled, above the great majority of these scales are translucent wood-brown, the remainder are translucent. Beneath the heavy scale covering is hoary-white.

Distribution.—As the species is known from but one specimen, we are only able to give one locality in the state of Oaxaca, Mexico, at which it is found, and nothing is known of the habits of the insect.

Specimens Examined.—1 ♂.

Salina Cruz, Oaxaca, Mexico; December 22, 1898; 1 ♂. (TYPE.) [Hebard Collection.]

Cryptoptilum contectum[32] n. sp.

This insect shows the closest relationship to *C. trigonipalpum* (*vide infra*), from which species it differs in the somewhat heavier build, which, however, is not as heavy as in *C. antillarum*. The pronotum is proportionately more expansive both in length and width in the male, and in fact considerably exceeds the broader species *antillarum*. The caudal femora are more strongly inflated, and in this respect closely resemble *antillarum*. In the female the pronotum is wider, being in proportionate width intermediate between *trigonipalpum* and *antillarum*, the subgenital plate differs from all other species of the genus in being apically keeled, and the ovipositor is also very much shorter than in any of the other forms.

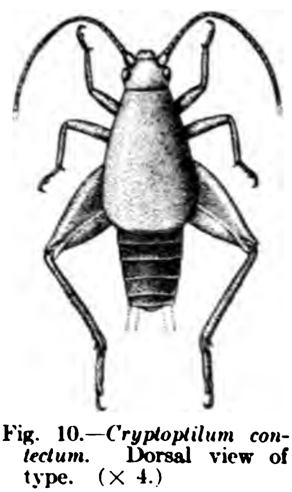


Fig. 10.—*Cryptoptilum contectum.* Dorsal view of type. (× 4.)

TYPE: ♂; Hayti. (P. R. Uhler.) [Scudder Collection.]

Description of Type.—Size small: form not as slender as *C. trigonipalpum*. Head small, the interantennal space roundly produced, divided vertically by a distinct though minute sulcus. Maxillary palpi as in *trigonipalpum*. Pronotum narrowing regularly cephalad, very wide and considerably produced caudad. Cerci of type missing. Cephalic face of cephalic tibiæ bearing a large, distinct, broadly ovoid tympanum. Hind femora and armament of limbs as in *C. antillarum*.

Allotypic ♀. Data the same as the type.

[32] In allusion to the expansive pronotum of the male of this species.

Description of Allotype.—Much the same size as the male. Pronotum proportionately wider than in *C. trigonipalpum*, narrower than in *C. antillarum*. Tegmina absent. Subgenital plate arcuato-convergent laterad, semi-ovate, carinate meso-caudad, very narrowly acute-angulate emarginate at the apex. Ovipositor much shorter than in the other species of the genus.

Measurements (in millimeters.)

	♂ Type. Hayti.	♀ Allotype. Hayti.
Length of body	7.2	7.1
Length of pronotum	4.7	2.1
Caudal width of pronotum	3.	2.
Length of caudal femur	4.5	4.9
Greatest width of caudal femur	1.9	2.
Length of ovipositor	....	3.6

Color Notes.—Head, antennæ, pronotum and limbs cinnamon. The pronotum of the female and first abdominal segments with dorsal surface somewhat darker, approaching mars-brown. Abdomen of male black, all but the dorsal surface of the proximal segments the same color in the female. Ovipositor russet. Scales on dorsal surface translucent wood-brown, appearing silvery to the naked eye; on the ventral surfaces of head and edges of the abdominal segments the scales are hoary-white; the heavy covering of scales on the limbs is of the same color. On all but the edges of the abdominal segments on the ventral surface of the abdomen, the scales are translucent wood-brown.

Distribution.—The species is known from but two specimens from the island of Hayti, and we have no information concerning the habits of the insect.

Specimens Examined.—1 ♂, 1 ♀.

Hayti; (P. R. Uhler); 1 ♂, 1 ♀. (♂ Type.) [Scudder Collection.]

Cryptoptilum trigonipalpum n. sp.

1905. *Cycloptilus americanus* Morse (not of Saussure, 1874), Psyche, XII, p. 21. [Nassau, New Providence Island, Bahamas.]
1907. *Liphoplus krugii* Rehn and Hebard (not of Saussure, 1897), Proc. Acad. Nat. Sci. Phila., 1907, p. 316 (in part). [Pablo Beach and San Pablo, Florida.]
1911. *Cycloptilus squamosus* Sherman and Brimley (not of Scudder, 1868), Ent. News, XXII, p. 391 (in part). [Raleigh, North Carolina.]

This species differs from *C. antillarum* in the average smaller size over the major portion of its range, the more graceful build, the more

pronounced interantennal sulcus and very different terminal joint of the maxillary palpi, the edges of which when viewed from the side form an isosceles triangle, owing to the fact that this joint expands widely distad and is very obliquely truncate. The pronotum is proportionally narrower and smaller in both sexes, the caudal femora are less strongly inflated, while in the male the subgenital plate is very slightly less produced obtuse-angulate and in the female it is semi-ovate, broadly obtuse-angulate emarginate at the apex.

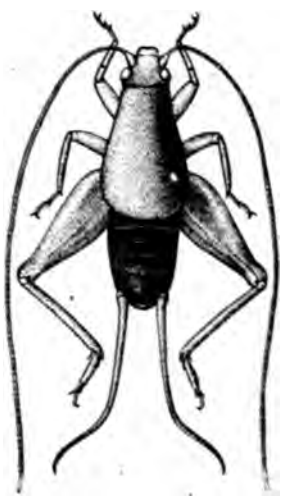
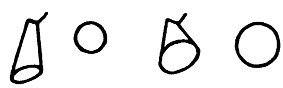


Fig. 11.—*Cryptoptilum trigonipalpum.* Dorsal view of type. (× 4.)

TYPE: ♂; Isle of Hope, Chatham County, Georgia, in heavy undergrowth of green plants and vines, September 3, 1911. (Rehn and Hebard.) [Hebard Collection.]

Description of Type.—Size smaller and more slender than *C. antillarum.* Head very small, the interantennal space roundly produced, divided vertically by a distinct though minute sulcus. Maxillary palpi with greatest length of terminal joint a very little more than greatest length of penultimate joint. Terminal joint conical, sharply expanding distad, very obliquely truncate, so much so that when viewed from the side the edges form an isosceles triangle, the equal sides

Fig. 12.—*Cryptoptilum trigonipalpum.* Maxillary palpus. (Greatly magnified.)



Figs. 13–16.—Oblique views and relative terminal circumference of distal joint of maxillary palpus of *Cryptoptilum antillarum* (figs. 13, 14) and *C. trigonipalpum* (figs. 15, 16). (Greatly magnified.)

formed by the diameter of the apex and the shortest lateral dimension. Pronotum narrower than in *antillarum,* general form of pronotum and tegmina as in that species. Cerci nearly as long as the length of the entire body. Cephalic face of cephalic tibiæ with tympanum as in *antillarum.* Hind femora considerably less dilated than in *antillarum,* armament of limbs similar.

Allotypic ♀. Data the same as the type.

Description of Allotype.—Slightly larger than male. Pronotum, mesonotum and metanotum noticeably narrower than in *antillarum*, bringing into prominence the depressed ovate abdomen. Tegmina absent. Subgenital plate semi-ovate, broadly obtuse-angulate emarginate at apex. Ovipositor as in *antillarum*.

In addition to the type and allotype, the following specimens may be considered paratypic: Isle of Hope, Ga.; Sept. 3, 1911; (R. and H.); 1 ♂ n. Sandfly, Ga.; Sept. 3, 1911; (R. and H.); 1 ♀.

Measurements (in millimeters).

	TYPE. Isle of Hope, Ga.	ALLOTYPE. Isle of Hope, Ga.	Charlotte Harbor, Fla.	Key Largo, Fla.
	♂	♀	♂	♀
Length of body	7.1	8.	6.8	7.8
Length of pronotum	4.	2.1	3.7	2.
Caudal width of pronotum	2.5	2.	2.4	2.
Length of caudal femur	5.	5.	4.2	5.1
Greatest width of caudal femur	1.7	1.8	1.3	1.9
Length of ovipositor	......	5.2	......	4.

	Florence, S. C.		Average of entire adult series.	
	♂	♀	♂♂	♀♀
Length of body	7.	8.5	7.	7.9
Length of pronotum	4.1	2.1	3.9	2.
Caudal width of pronotum	2.5	2.1	2.4	2.
Length of caudal femur	5.	5.5	4.4	5.
Greatest width of caudal femur	1.6	1.8	1.6	1.7
Length of ovipositor	......	6.2	......	4.8

The measurements would indicate that this species is smaller than specimens of *antillarum* from the same place over the greater portion of its range, but as it decreases in size southward much less rapidly than that species, the two species are very nearly of the same size in southern Florida, though their proportions markedly differ.

Color Notes.—There is scarcely any difference in ground coloration between *antillarum* and the present species, except that, in the series of the latter species before us, the maxillary palpi are never darkly suffused, though of a richer brown than the surrounding facial parts, and all have the dorsal surface of the abdomen wholly black. The insects are thickly covered with nearly transparent scales, so that in the field they frequently appear to have the black abdomen ringed above at the intersection of the segments with whitish scales, due

to the fact that at the juncture of the segments the scales are somewhat raised, and the refraction of light gives them a whitish appearance where such refraction occurs.

Distribution.—This species is now known to occur in the Bahama Islands and the southeastern United States. The series shows the range of the species to extend from east-central North Carolina to the northern Florida Keys and New Providence Island, Bahamas.

Biological Notes.—This species was not always recognized in the field as different from *antillarum*, although on one or two occasions the notes refer to it as a different species. From our notes we are therefore only able to state that the species occurs often in the same general region with *antillarum*, but it is probable that it seeks rather heavier growth than that species, as the following field note would suggest. "The Jungle *Liphoplus*[33] has scales only on under side and around segments of abdomen giving it a ringed appearance and a strikingly red and black color when compared with *Liphoplus krugii*, which species is covered with sparse silvery scales, pronotum and all."

Specimens Examined.—24; 8 males, 8 females and 8 nymphs.

Raleigh, N. C.; Sept., 1908; (Sherman); 1 ♂. [Coll. N. C. Dept. Agr.]

Lake Waccamaw, N. C.; Sept. 8, 1911; (R. and H.); 1 ♀.

Florence, S. C.; Sept. 6, 1911; (R. and H.); 1 ♂, 1 ♀.

Sullivan Id., Charleston Co., N. C.; Sept. 5, 1911; (R. and H.); 1 ♀.

Isle of Hope, Ga.; Sept. 3, 1911; (R. and H.); 1 ♂, 1 ♀, 1 ♂ n. (♂ TYPE; Hebard Collection).

Sandfly, Ga.; Sept. 3, 1911; (R. and H.); 1 ♀.

Jacksonville, Fla.; (Pridday); 1 ♀. [Hebard Collection]: Aug. 25, 1911; (R. and H.); 2 ♂.

Atlantic Beach, Fla.; Aug. 24, 1911; (R. and H.); 1 ♀ n.

Pablo Beach, Fla.;[34] Aug. 13, 1905; (R. and H.); 1 ♂ n.

San Pablo, Fla.;[34] Aug. 13, 1905; (R. and H.); 1 ♂, 1 ♀ n.

Charlotte Harbor, Fla.; 1 ♂. [Scudder Collection.]

Punta Gorda, Fla.; Nov. 13, 1911; (W. T. Davis); 1 ♀. [W. T. Davis Collection.]

Key Largo, Fla.; March 18, 1910; (H.); 1 ♀, 3 ♂ n.

[33] To distinguish it from *C. antillarum* which was then called *Liphoplus krugii*.

[34] These specimens were recorded as *Liphoplus krugii* by the authors, these PROCEEDINGS, 1907, p. 316. At that time so few specimens of the group from North America had been taken, and genera were so confused, that it was almost impossible to determine with accuracy any of the species. The authors' notes in that paper on *Liphoplus*, *Cycloptilum* and *Ectatoderus* are wholly erroneous.

Nassau, New Providence Island, Bahamas; Jan. 31, 1905; (A. E. Wright); 1 ♂, 1 ♂ n.[35] [Morse Collection.]

Genus **CYCLOPTILUM** Scudder.

1868. *Cycloptilum* Scudder, Proc. Bost. Soc. Nat. Hist., XII, p. 142.
1874. *Cycloptilum* Saussure, Miss. Sci. Mex., Rech. Zool., VI, p. 425 [in part].
1877. *Cycloptilus* Saussure, Mélang. Orth., II, p. 477 [in part].
1897. *Cycloptilus* Saussure, Biol. Cent. Amer., Orth., I, p. 231 [in part].
1897. *Cycloptilum* Scudder, Guide to Gen. Class, N. Amer. Orth., p. 64.
1905. *Liphoplus* Rehn and Hebard (not of Saussure, 1877), Proc. Acad. Nat. Sci. Phila., 1905, p. 49.
1909. *Ectatoderus* Rehn and Hebard (not of Guérin, 1849), *ibid.*, 1909, p. 482.
1909. *Cycloptilum* Davis, Jour. N. Y. Ent. Soc., XVII, p. 187.

Genus monotypic. GENOTYPE—*Cycloptilum squamosum* Scudder.

Generic Description.—Form depressed, compact; surface clothed with scales; pronotum produced caudad in male; tegmina absent in female, projecting beyond pronotum in male.

Head small, rounded, produced cephalad; interantennal protuberance with trace of vertical division. Pronotum of male narrow cephalad, broadened and produced caudad, in length equal to about half of the entire length of the body; of female subquadrate. Tegmina of male extending caudad of caudal margin of pronotum a distance subequal to one-third the greatest pronotal length, tympanum perfectly developed, caudal margin of dorsal field of tegmina strongly arcuate; lateral field of tegmina well developed. Ovipositor nearly straight, sub-lanceolate at apex, the latter with margins unarmed. Subgenital plate of female with distal margin complete or distinctly but transversely emarginate mesad. Cerci of both sexes elongate, tapering. Cephalic tibiæ with the cephalic face bearing a distinct tympanum. Caudal femora greatly dilated; caudal tibiæ with three pair of well-developed distal spurs, the dorso-internal shorter than the ventro-internal spur; caudal metatarsus sulcate dorsad, serrate on both dorsal margins, the distal extremity armed on both sides with a spur which extends well beyond the base of the distal tarsal joint.

Distribution in North America.—Extending from central New Jersey southward to extreme southern Florida, westward in the South through Texas to southern Arizona and the Mojave Desert in

[35] The specimens from this locality recorded as *Cycloptilus americanus* by Morse, *Psyche*, XII, p. 21, 1905, cannot be found. The present specimens from the collection of Professor Morse were determined by him as that same species, but the records have not been published. We feel, therefore, confident that those specimens recorded as *Cycloptilus americanus* are the authors' new species, *Cryptoptilum trigonipalpum*, to which the present specimens unquestionably belong.

California, and northward to northern Nebraska and extreme northeastern Colorado.

Key to Cycloptilum Scudder.

A. Size small; pronotum of male with cephalic portion of dorsum well rounded, caudal portion broadened and distinctly flattened; the lateral outline of the pronotum when seen from above expanding more sharply caudad; pronotum of female small; ovipositor 3 mm. or over .... *squamosum* Scudder.

AA. Size very small; pronotum of male with entire dorsum transversely well rounded, caudal portion not so much broadened; the lateral outline of the pronotum when seen from above expanding regularly but very slightly; pronotum of female very small; ovipositor less than 3 mm., *zebra* (Rehn and Hebard.)

Cycloptilum squamosum Scudder.

1868. *Cycloptilum squamosum* Scudder, Proc. Bost. Soc. Nat. Hist., XII, p. 142. [Texas.]
1874. *Cycloptilum squamosum* Saussure, Miss. Sci. Mex., Rech. Zool., VI, p. 427. [Texas.]
1877. *Cycloptilus squamosus* Saussure, Mélang. Orth., II, p. 477. [Texas.]
1891. *Cycloptilus borealis* Bruner, Can. Ent., XXIII, p. 37. [Near Niobrara River at Valentine and Lincoln, Nebraska.]
1893. *Cycloptilum boreale* Bruner, Publ. Nebr. Acad. Sci., III, p. 33. [Central and Northern Nebraska.]
1897. *Cycloptilus squamosus* Saussure, Biol. Cent. Amer., Orth., I, p. 231. [Dallas, Texas.]
1903. *Cycloptilus squamosus* Caudell, Proc. U. S. Nat. Mus., XXVI, p. 808. [Victoria, Texas.]
1905. *Cycloptilum squamosum?* Rehn and Hebard, Proc. Acad. Nat. Sci. Phila., 1904, p. 799. [Thomasville, Georgia.]
1907. *Liphoplus krugii* Rehn and Hebard, *ibid.*, 1907, p. 361 (in part). [San Pablo and Gainesville, Fla.]
1909. *Ectatoderus occidentalis* ? Rehn and Hebard, *ibid.*, 1909, p. 482. [Cottonwood, California.]
1909. *Cycloptilum squamosum* Davis, Jour. N. Y. Ent. Soc., XVII, p. 187. [Lakehurst, New Jersey.]
1910. *Cycloptilus squamosus* Allard, Proc. Ent. Soc. Wash., XII, p. 42. [Thompson's Mills, Georgia.]
1910. *Cycloptilus squamosus* Rehn in Smith, Ann. Rept. New Jersey State Mus., 1909, p. 191. [Lakehurst, New Jersey.]
1911. *Cycloptilus americanus* Sherman and Brimley (not *Cycloptilum americanum* Saussure, 1874), Ent. News, XXII, p. 391. [Raleigh and "Alamance County," North Carolina.]

TYPE: ♂; Texas. (Belfrage.) [Scudder Collection.]

Description of Type.—Size small for the group, head very small, interantennal protuberance well produced, rounded, with trace of vertical division. Maxillary palpi with penultimate joint not more than two-thirds as long as terminal joint, the latter gently expanding distad, gently obliquely truncate. Eyes reniform in outline, subvertical. Pronotum strongly narrowed cephalad, considerably

broadened and produced caudad, its caudal margin forming nearly a semicircle, the cephalic portion of the dorsum well rounded, the broadened caudal portion of the dorsum distinctly flattened. Tegmina with dorsal field as broad as pronotum at its widest part, tympanum perfectly developed, caudal margin of tegmina subequal in arcuation to the caudal margin of the pronotum; lateral field of tegmina well developed, embracing abdomen; the cephalic two-thirds of the tegmina concealed by the pronotum, the visible portion extending caudad of the caudal margin of the pronotum a distance subequal to one-third the greatest pronotal length.

Cerci more than one-half as long as abdomen. Cephalic tibiæ with cephalic face bearing a distinct tympanum. Caudal femora greatly dilated. Caudal tibiæ with three pair of well-developed distal spurs, the dorso-internal very slightly shorter than the ventro-internal spur, the medio-internal spur is the longest and has its length

Fig. 17.—*Cycloptilum squamosum.* Dorsal view of type. (× 4.)

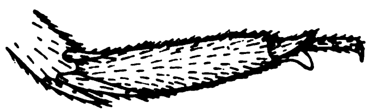


Fig. 18.—*Cycloptilum squamosum.* Internal face of caudal metatarsus and internal tibial spurs. (Greatly magnified.)

contained two and one-quarter times in the metatarsus. Caudal metatarsus rather long, straight, rather broad, sulcate dorsad, both dorsal margins armed with short, well-separated serrations five on inner and eight on outer margin,[36] the distal extremity armed on both sides with a spur, the somewhat longer inner spur reaching to nearly the end of the first quarter of the terminal tarsal joint.

Allotypic ♀: Dallas, Texas. [United States National Museum Collection.]

Description of Allotype here Selected.—The specimen differs from the male type in that it is somewhat larger, the pronotum is subquadrate, narrowing very slightly cephalad, and the tegmina are absent. The subgenital plate is arcuato-convergent laterad, with

[36] See note under *Cryptoptilum antillarum* concerning variability as to number of these serrations.

distal section of margin complete.[37] The ovipositor is fairly long and nearly straight, somewhat elongate sublanceolate at apex, the base alone showing a slight upward curvature, lateral division of valves exactly at middle of sides, the apex with margins unarmed. Length of ovipositor contained in length of cerci nearly one and one-quarter times.

Measurements (in millimeters).

	Type. Texas.	Allotype. Dallas, Tex.	*C. borealis* Br. Allotype. Lincoln, Neb.	*C. borealis* Br. Type.
	♂	♀	♂	♀
Length of body	6.3	7.2	6.6[38]	6.2
Length of pronotum	3.4	2.2	3.	2.1
Caudal width of pronotum	2.9	2.1	2.6	2.
Length of caudal femur	3.5	4.2	3.9	4.1
Greatest width of caudal femur	1.5	1.8	1.8	1.9
Length of ovipositor	.....	3.6	......	3.

	Cumberland Island, Georgia.		Wrightsville, North Carolina.	
	♂	♀	♂	♀
Length of body	6.1	6.3	6.1	6.
Length of pronotum	3.3	2.	3.4	2.
Caudal width of pronotum	2.7	1.9	2.6	1.9
Length of caudal femur	4.	4.4	4.1	3.7
Greatest width of caudal femur	1.7	1.8	1.5	1.5
Length of ovipositor	..	3.	......	3.

Measurements taken of a large series from St. Simon's Island, Georgia, show that there is an equal or greater amount of variation among individuals from that locality than is found in the specimens whose measurements are given above. Length of body: ♂, 5.4–6.9 mm.; ♀, 5.6–6.9: length of pronotum; ♂, 3.1–3.9; ♀, 2–2.1: caudal width of pronotum: ♂, 2.5–2.7; ♀, 1.9–2: length of caudal femur; ♂, 3.8–4.2; ♀, 3.5–4.2: greatest width of caudal femur; ♂, 1.3–1.8; ♀, 1.6–1.9: length of ovipositor; 3.6–2.9.

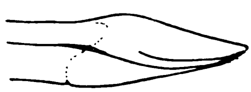


Fig. 19.—*Cycloptilum squamosum*. Apex of ovipositor. (Greatly magnified.)

Color Notes.—Over the more arid portions of the range of this species (which includes the type locality) the general color of the insects is rather pale brown, the entire body more or less covered

[37] For variability of this character see note in "Remarks."
[38] Appears to have been somewhat squeezed out.

with silvery or yellowish scales, while a post-ocular bar of darker scales frequently extends as a narrow line of dark scales along the dorsal edge of the lateral lobes of the pronotum to its caudal margin. In specimens which have lost their scaly covering no trace of such a line exists, the ground color of head, pronotum, limbs and first two or three segments of the abdomen is found to be russet, while the remainder of the abdomen is black. The maxillary palpi are much suffused with blackish, this is most pronounced in the darkest specimens. The ovipositor is vandyke-brown.

Specimens from Nebraska show, in individuals which have lost their scaly covering, the same coloration, but when fully clothed with scales their appearance is rather more yellowish, owing to the fact that in these individuals a greater proportion of their scales are more yellowish than in specimens from the arid West.

Individuals from the Atlantic coast are similar to western specimens in body coloration, but their scale covering is usually composed chiefly of blackish or slate-colored scales, which gives the specimens a dark and somewhat mottled appearance quite different from that of western representatives of the species. This difference in coloration is augmented by the fact that while in western individuals the caudal margin of the tegmina is marked with a few faintly darker veins, the Atlantic coast representatives of the species have this margin heavily and strikingly velvety black.

Distribution.—This species is now known to range from central New Jersey southward on the Atlantic coast to north-central Florida, westward across Texas and southern Arizona as far as the Mojave Desert in California, in the middle west north to the northern boundary of Colorado, and over the entire central and northeastern portions of Nebraska.

This distribution is rather surprising owing to the fact that the species is to be found both in the humid regions of the East and the areas of extreme aridity of the Southwest. The vertical range of the species is known to extend from sea level to an elevation of 3,550 feet on the Great Plains, 2,274 feet in the Mojave Desert, and 2,500 feet in Pima County, Arizona.

Biological Notes.—At Cottonwood, California,[39] this species was common under creosote bush (*Covillea*), where, among the collected refuse at the base of the bushes, the insects were heard shrilly stridulating at dusk and later. The sound produced was an incessant and

[39] *Proc. Acad. Nat. Sci. Phila.*, 1909, p. 482.

high-pitched zeee-zeee-zeee. Along the Atlantic coast the authors have found the species under boards and various other debris on the ground, usually along the edge of, or in forest growth, and almost always in very small numbers. Once, however, a locality was examined where the little insects were present in countless numbers; this was on St. Simon's Island, Georgia, where myriads were found jumping about among the dead leaves and very few low plants and grasses growing on the sandy soil under live oaks. Professor Bruner has stated that the synonymous *C. borealis* is common in Nebraska among dry grass and under boards on sandy soil.

Synonymy.—As we have before us one male and fifteen females of the typical series of *Cycloptilus borealis* Bruner, we are enabled to refer it unhesitatingly to the present species. There are no differences between these specimens and the type and allotype of *squamosum*, except in the coloration of the scaly covering which in the present species is exceedingly variable. We find Scudder's measurements to be accurate, while those given by Bruner in the original description of *borealis* are quite different from what we find to be the case in the typical series, which in size and proportions can in no way be separated from *squamosum*.

Remarks.—In the series of females before us, the distal section of the margin of the subgenital plate varies from a type which is arcuato-convergent laterad with the distal section of the margin complete, to one which has the distal section of the margin broadly emarginate, this emargination flanked laterad by acute spiniform angles. The majority of specimens from the Atlantic coast have this emargination present, while it is absent in the majority of western specimens, but an examination of the series shows that it is not constant and that in this species the entire form of the subgenital plate is exceedingly variable in the female sex, while in the male it is simple and broadly arcuate.

Specimens Examined.—215; 83 males, 115 females, and 17 nymphs.

Piney Point, Md.; Sept. 14, 1902; (Pergande); 1 ♀. [U. S. N. M.]

Raleigh, N. C.; Oct. 2, 1903; 1 ♀: Aug. 16, 1906; 1 ♂: Oct. 30, 1907; 1 ♂, 1 ♀: Sept. 30, 1898; 2 ♀. (All Brimley.) [Brimley Collection.]

Wilmington, N. C.; Sept. 8, 1911; (R. and H.); 1 ♂.

Winter Park, N. C.; Sept. 7, 1911; (R. and H.); 1 ♀.

Wrightsville, N. C.; Sept. 7, 1911; (R. and H.); 2 ♂, 1 ♀.

Florence, S. C.; Sept. 6, 1911; (R. and H.); 1 ♂.

Yemassee, S. C.; Sept. 4, 1911; (R. and H.); 1 ♂, 1 ♀.

Thompson's Mills, Ga.; Oct. 1909; (Allard); 1 ♂, 1 ♀. [U. S. N. M.]

Isle of Hope, Ga.; Sept. 3, 1911; (R. and H.); 4 ♂, 2 ♀.
St. Simon's Id., Ga.; Aug. 30, 1911; (R. and H.); 48 ♂, 56 ♀, 3 ♀ n.
Cumberland Id., Ga.; Aug. 31, 1911; (H.); 6 ♂, 13 ♀, 5 ♀ n.
Brunswick, Ga.; Aug. 30, 1911; (H.); 1 ♂, 3 ♀.
Thomasville, Ga.; Aug. 3, 1903; (for H.); 1 ♂ n.
Atlantic Beach, Fla.; Aug. 25, 1911; (R. and H.); 1 ♂, 3 ♀.
San Pablo, Fla.;[40] Aug. 13, 1905; (R. and H.); 1 ♀, 1 ♀ n.
Live Oak, Fla.; Aug. 26, 1911; (R. and H.); 1 ♂ n.
Gainesville, Fla.;[40] Aug. 16, 1905; (R. and H.); 1 ♀.
Texas; (Belfrage); 2 ♂.[41] [Scudder Collection.]
Dallas, Tex.; 2 ♀, 1 ♂ n. [U. S. N. M.]
Columbus, Tex.; May 31; 1 ♂. [U. S. N. M.]
New Braunfels, Tex.; Sept. 8; (Schwarz); 1 ♂, 1 ♂ n. [U. S. N. M.]
Victoria, Tex.; June; (Caudell); 1 ♂ n. [U. S. N. M.]
Calhoun County, Tex.; (J. W. Mitchell); 1 ♀. [U. S. N. M.]
Carrizo Springs, Tex.; (A. Wadgymar); 3 ♂, 3 ♀. [Hebard Collection.]
Brownsville, Tex.; May 13–24, 1904, June 6, 1904; (Barber); 6 ♂, 1 ♀, 1 ♂ n. 1 ♀ n. [U. S. N. M., A. N. S. P., Hebard Collection.]
Tumamoc Hill, Tucson Mts., Ariz.; Oct. 3–4, 1910; (R. and H.); 2 ♀.
Snyder's Hill, Pima Co., Ariz.; Oct. 11, 1910; (R. and H.); 1 ♀.
Tinajas Altas, Yuma County, Ariz.; 1905; (W. J. McGee); 1 ♀. [U. S. N. M.]
Cottonwood, San Bernardino County, Cal.; Sept. 9, 1907; (H.); 1 ♂.
Julesburg, Colo.; July 29, 1910; (H.); 1 ♂ n.
Lincoln, Nebr.; Sept. 1888; 1 ♂, 15 ♀.[42]
Sidney, Nebr.; 1 ♀. [Hebard Collection.]

Cycloptilum zebra (Rehn & Hebard).

1905. *Liphoplus zebra* Rehn and Hebard, Proc. Acad. Nat. Sci. Phila., 1905, p. 49, pl. I, fig. 12. [Miami, Florida.]

At the time of the original description the authors were not acquainted with the Scudderian genus *Cycloptilum*, and Saussure's misconception led us to suppose that the present species did not belong to that genus. We are now able to state definitely the following facts:

[40] These specimens were unfortunately recorded as *Liphoplus krugii* by the authors. These PROCEEDINGS, 1907, p. 316.

[41] One of these two specimens is the unique type of *Cycloptilum squamosum* Scudder.

[42] These are from the paratypic series of *Cycloptilus berealis* Bruner, which are divided as follows: 1 ♂, 10 ♀ (including the single type and allotype), Hebard Collection; 2 ♀, Acad. Nat. Sci. Phila.; 1 ♀, U. S. N. M.; 2 ♀, Scudder Collection.

The present species is distinguished from *Cycloptilum squamosum* by its smaller size, relatively more regularly convex dorsal surface of the pronotum in the male, which is less expanded caudad and is much shorter. In the female the pronotum is very small and narrows somewhat more cephalad. Proprtionately, the limbs are shorter and the caudal femora more flea-like. Differences in coloration are also apparent and are given in the color description below.

TYPE: ♂; Miami, Dade County, Florida, on wire-grass in low undergrowth of pine woods, February 6, 1904. (Hebard.) [Hebard Collection.]

Description of Type.—Size very small for the group. Head with interantennal protuberance much as in *squamosus*, but the perpendicular division is somewhat more apparent, very narrow but distinct. Maxillary palpi with penultimate joint not more than two-thirds as long as terminal joint, the latter gently expanding distad and gently obliquely truncate. Eyes reniform in outline, subvertical. Pronotum with cephalic width of dorsal surface approaching caudal width of the same more nearly than in *squamosum*, considerably produced caudad, its caudal margin forming nearly a semicircle, the whole of the dorsum well rounded. Tegmina with dorsal field slightly broader than pronotum at its widest point, tympanum perfectly developed, caudal margin of tegmina subequal in arcuation to the caudal margin of the pronotum. Cerci missing in type (in other males of this species the cerci are more than one-half as long as the abdomen). Cephalic tibiæ with cephalic face bearing a minute but distinct tympanum. Caudal femora more dilated than in *squamosum*. Caudal tibiæ with three pair of well-developed distal spurs, the dorso-internal very slightly shorter than the ventro-internal spur; the medio-internal spur is the longest and has its length contained two and one-quarter times in the metatarsus. Caudal metatarsus fairly long, straight, rather broad, sulcate dorsad, both dorsal margins armed with short, well separated serrations, much as in *C. squamosum*, the distal extremity armed on both sides with a spur which extends to nearly the end of the first third of the terminal tarsal joint.

Fig. 20.—*Cycloptilum zebra.* Dorsal view of type. (× 4.)

Allotypic ♀: Key West, Monroe County, Florida, on underside

of coquina boulder on sandy strand, March 16, 1910. (Hebard.) [Hebard Collection.]

Description of Allotype here Selected.—Very slightly larger than type. Pronotum subquadrate, narrowing perceptibly cephalad; tegmina absent. Ovipositor rather short, straight, somewhat elongate sub-lanceolate at apex, lateral division of valves exactly at middle of sides, the apex with margins unarmed. Subgenital plate arcuato-convergent laterad, distal section of margin flattened but with no emargination. Cerci reaching but very little beyond the tip of the ovipositor.

Measurements (in millimeters).

	TYPE. Miami, Fla. ♂	ALLOTYPE. Key West, Fla. ♀	Lake Worth, Fla. ♂	Long Key, Fla. ♀
Length of body	5.	5.	6.[43]	5.1
Length of pronotum	2.9	1.7	2.6	1.6
Greatest width of pronotum	1.9	1.8	1.7	1.6
Length of caudal femur	3.1	3.4	3.4	3.2
Greatest width of caudal femur	1.1	1.4	1.4	1.2
Length of ovipositor	.....	2.8	.....	2.7

	Average in Key West, Fla., series. ♂	♀
Length of body	5.2 (5. –5.5)	5.2 (4.9–5.5)
Length of pronotum	2.4 (2.3–2.6)	1.5 (1.3–1.7)
Greatest width of pronotum	2. (1.9–2.1)	1.7 (1.5–1.8)
Length of caudal femur	3.1 (3. –3.2)	3.5 (3.4–3.7)
Greatest width of caudal femur	1.2 (1.1–1.4)	1.3 (1.3–1.4)
Length of ovipositor	....	2.8 (2.7–2.9)

Color Notes.—The entire territory over which this species is known has much of its surface composed of rough coquina rock which rock is very white. The species is wholly terrestrial, and we find that its scaly covering is silvery, usually with limbs barred and body spotted and mottled with dark brown scales; this coloration so matches the surface of the coquina rock that the little insects are practically invisible when at rest. The insect is very much whiter in appearance than its larger relative *C. squamosum*, even where specimens of that species from the arid West are found covered with pale yellowish scales. The postocular bar is very dark in this species and in the entire series before us extends along the upper edge of the lateral

[43] Specimen much squeezed out, normal length probably about 5 mm.

lobes of the pronotum to the caudal margin. Rubbed specimens show that the ground color of the species on head, pronotum, mesonotum, metanotum and all of the limbs is very pale yellowish, while the abdomen is black and the ovipositor dark brown. Unlike in *squamosum*, the post-ocular bar mentioned above is present not only in scale coloration but ground coloration as well, while the lateral lobes of the pronotum are somewhat lighter in coloration than its dorsal surface. The maxillary palpi are usually light, the apical joint suffused with blackish distad, this darker suffusion in a few cases overspreading the last three joints. The tegmina are bone white, the caudal border lightly blotched with black.

Distribution.—Lake Worth, southward to Key West, Florida.

Biological Notes.—Nearly all of the specimens of this terrestrial species have been captured hiding on the under surface of coquina boulders near or on the strand; the type, however, was captured in the low undergrowth growing on rough coquina rock in the scattering pine woods back of Miami. The little insects have never been found more than two or three at a time, and usually a considerable area has to be carefully searched before any specimens are discovered. When first exposed they usually remain motionless and closely pressed to the surface of the rock under which they had been hiding; when disturbed, however, they spring about wildly and are so hard to follow with the eye that unless captured before they are thoroughly aroused, individuals have excellent chances of escaping.

Remarks.—This species is unquestionably closely related to *Cycloptilum squamosum*, and it is possible that it may prove to be a geographic race of that species limited to southern Florida. Without material from the region between Palm Beach and Jacksonville, however, we are unable to find the slightest suggestion of intergradation. The facts that the characters which separate *zebra* from *squamosum* are constant, and that the former species is invariably much the smaller, rather suggest that *zebra* is not a race at all, since over the tremendous range of *squamosum*, no such differences are to be found in that species.

In the entire series of females the subgenital plate is, without exception, arcuato-convergent laterad with the distal section of the margin flattened, but with no trace of the emargination and acute spiniform angles found in so many females of *squamosum* from the Atlantic coast.

Specimens Examined.—21; 6 males, 9 females and 6 nymphs.

Lake Worth, Fla.; (Slosson); 1 ♀, 2 n. [Scudder Collection.]; 1 ♂. [Hebard Collection.]

Miami, Fla.; February 6, 1904; (H.); 1 ♂ (TYPE). [Hebard Collection.]; (Slosson); 1 n. [Scudder Collection.]

Long Key, Fla.; March 13, 1910; (H.); 1 ♀. [Hebard Collection.]

Key West, Fla.; March 15, 16, 1910; (H.); 4 ♂, 7 ♀, 3 ♂ n.[44]

OLIGACANTHOPUS[45] new genus.

1905. *Mogoplistes* Rehn and Hebard (not of Serville, 1839), Proc. Acad. Nat. Sci. Phila., 1905, p. 4.

Genus monotypic. GENOTYPE—*Oligacanthopus prograptus* n. sp.

This genus, known from a single female, is widely separated from all others of the group. In some respects a relationship, or development along similar lines to *Glaphyropus*, is apparent; this is shown in the compact build, rounded head, small eyes, broadly rounded and but little produced interantennal space, which is not divided by a vertical sulcus, and similar caudal femora.

With these characters, however, similarity to *Glaphyropus* ceases and we find, instead, a close relationship to *Cycloptilum* in the following respects: maxillary palpi very much like those found in *Cycloptilum*, cephalic and median limbs also similar, very different from the elongate type found in *Glaphyropus;* ovipositor of the type of *Cycloptilum*, but somewhat arcuato-convex and differing from all other known North American members of the group in having the ventral margins of the apex armed distad with a row of minute but true serrulations; cerci of the type found in *Cycloptilum*, caudal tarsi even shorter and proportionally heavier; armament of limbs of the same type as found in *Cycloptilum* but reduced in size to an extreme degree; the metatarsi are proportionally very long, nearly intermediate between *Glaphyropus* and *Cycloptilum*, but more closely approaching the former, the dorsal margins armed with serrulations similar to those of *Cycloptilum*, but so fine that they apparent only in a good light under a microscope. Consequently we see that the caudal limbs are most peculiar in having proportions and armament differing strikingly from any other known species; the caudal femora are elongate and not at all flea-like, the tarsi are very short, quite heavy and armed with minute distal spurs, while the metatarsi are proportionally very long and slender, their dorsal margins so finely serrate that these could almost be termed unarmed and their terminal spurs minute.

[44] These specimens are distributed as follows: 1 ♂, 3 ♀, 3 ♀ n., Hebard Collection; 1 ♂, 2 ♀, A. N. S. P.; 1 ♂, 1 ♀, U. S. N. M.; 1 ♂, 1 ♀, Mus. Comp. Zool.

[45] From ὀλίγος, small, ἄκανθα, thorn, and πούς, feet; in allusion to the very small tarsal spurs.

When compared with *Mogoplistes* the following differences are found. Head very different, ovoid, interantennal protuberance not as produced and with no vertical sulcus, eyes not so protuberant; pronotum with dorsal surface more flattened; caudal femora shorter, caudal tarsi very much shorter, proportionally very much longer caudal metatarsi; armament of limbs different, as in *Cycloptilum*, but all of the spurs and serrulations much smaller. The ovipositor in *Mogoplistes* is straight, rather long, with lateral division of valves exactly at middle proximad, but rising sharply and much nearer the dorsal margin over the greater length of the ovipositor, the apex is not widened and is armed on the ventral edge of the dorsal valves with blunt, knob-like serrations, while the surface of the dorsal valves is finely punctate. In *Oligacanthopus* the ovipositor is very different from this as may be seen by reference to the description.

Generic Description.—Head small, transverse, subelongate, smooth, interantennal protuberance weak, broadly rounded, flattened distad, no vertical dividing sulcus present; eyes pyriform, very slightly inflated; maxillary palpi not very long, gently expanding distad, the distal joint mildly obliquely truncate. Pronotum of female subquadrate in form, cephalic margin subtruncate, weakly arcuato-emarginate, caudal margin weakly arcuate, leaving the entire metanotum exposed. Tegmina absent in female. Ovipositor very gently arcuato-convex, very short, somewhat elongate sublanceolate at apex, lateral division of valves exactly at middle of sides, the surface of apex smooth, the ventral margins of the ventral valves armed distad with a row of minute serrulations. Subgenital plate of female rotundato-trigonal. Cerci elongate, subcrassate, tapering. Caudal femora dilated; caudal tibiæ proportionately heavy and short, minutely serrulate on dorsal margins, with three pair of distal spurs, the dorso-internal shorter than the ventro-internal; caudal metatarsus elongate, proportionately slender, equal to over one-half the caudal tibia in length, dorsal margins supplied with minute serrulations, second joint not quite as long as third joint.

Distribution in North America.—Extreme southern Florida.

Oligacanthopus prograptus[46] n. sp.

1905. *Mogoplistes slossoni* Rehn and Hebard (not *Mogosiplistus slossoni* Scudder, 1897), Proc. Acad. Nat. Sci. Phila., 1905, p. 48. [Miami, Florida.]

TYPE: ♀; Miami, Dade County, Florida, under sign on oak in "hammock," February 6, 1904. (Hebard.) [Hebard Collection.]

[46] From πρό, in front, and γραπτός, that which is written upon; in allusion to the striking dark bars on the facial protuberance.

Description of Type.—Size small; form depressed, compact; surface covered heavily with scales. Head ovoid, occipital outline depressed,

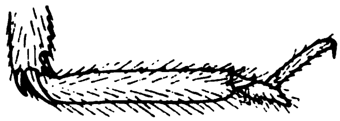


Fig. 21.—*Oligacanthopus prograptus.* Internal face of caudal metatarsus and internal tibial spurs. (Greatly magnified.)

weakly arcuate dorsad; interantennal protuberance separated from vertex by a well-marked transverse interantennal sulcus. Maxillary palpi with penultimate joint not more than two-thirds as long as terminal joint, the latter gently expanding distad, gently obliquely truncate. Pronotum with dorsum transversely very gently arcuate, curving sharply laterad, caudal width subequal to length, lateral outlines of disk straight, subparallel; lateral lobes passing into disk with an angulation but slightly indicated, depth of lobes over one-quarter their greatest length, ventral margin sinuato-truncate. Subgenital plate arcuato-trigonal, subcompressed. Ovipositor shorter than caudal femur, gradually thickened proximad, very gently arcuato-convex, somewhat elongate sublanceolate at apex, the surface of apex smooth, the ventral margins of the ventral valves armed distad with a row of minute serrulations. No tympanum present on the cephalic tibiæ. Caudal tibiæ straight; armament of same similar to that found in *Cycloptilum*, but greatly reduced in size, much smaller than in any other known North American species of the Mogoplistii, the medio-external spur nearly twice the length of the dorso- and ventro-external spurs. Caudal metatarsus straight, subcompressed; distal spurs reduced to very small heavy teeth which are sharply upcurved distad and scarcely reach the base of the

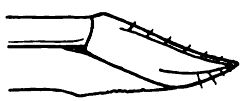


Fig. 22.—*Oligacanthopus prograptus.* Apex of ovipositor. (Greatly magnified.)

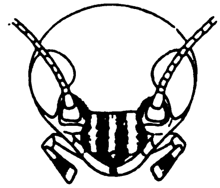


Fig. 23.—*Oligacanthopus prograptus.* Cephalic aspect of head. (Much enlarged.)

second tarsal joint, which is twice the length of one of these external spurs; these, as is true also in the tarsal spurs, are longer than the homologous internal spurs.

Measurements (in millimeters).—♀: Length of body, 5.8; length of pronotum, 1.5; caudal width of pronotum, 1.4; length of caudal femur, 3.7; greatest width of caudal femur, 1.2; length of caudal tarsus, 2; length of caudal metatarsus, 1.2; length of ovipositor, 2.5.

Color Notes.—So heavily covered with scales is the only specimen known that it is difficult to state the ground coloration of the insect. This coloration appears to be very pale wood-brown over the entire surface of the body; the interantennal protuberance never has the distal portion scaled, and in the present species this is strikingly marked with four parallel vertical bars of bistre separated by bars of the ground color of the same width, these somewhat more tinged with yellowish. The terminal joints of the maxillary palpi have also a broad band of bistre encircling their median portion, while the tip is more yellowish than the basal portion of the palpi which is of the prevailing very pale wood-brown. The antennæ are colored as the tips of the maxillary palpi, but have the third, sixth, tenth and sixteenth joints on each side bistre. The scaly covering is composed of silvery scales among which darker ones are found in confused masses, the tarsi all are distinctly twice banded with these scales, and in addition the base of the caudal tarsis is so darkened. The general effect is that of an irregularly mottled silvery hair-brown insect with banded limbs.

Biological Notes.—Although but a single specimen of this species has been captured, others were seen. All of these were observed at Miami, Florida, in the heavy semi-tropical "hammock" on the south bank of the Miami River, and were found by prying up loose pieces of bark and tearing off signs on the low oak trees. When exposed the insects sprang wildly about, to which habit is due the fact that but a single specimen was taken.

Distribution.—Miami, Dade County, Florida.

Synonymy.—When the specimen, on which this species is based, was first recorded, the authors confused it with Scudder's *Mogosiplistus slossoni* [*Cryptoptilum antillarum*] partially owing to the fact that Saussure had stated that the interantennal protuberance of *Mogoplistes* (*Mogisoplistus* Saussure, 1877; not *Mogosiplistus* Scudder, 1897) was not divided by a median vertical sulcus. Specimens from Saussure before us of the type of that genus, *Mogoplistes brunneus*, prove that though the interantennal protuberance is not absolutely divided by a sulcus, still it shows a distinct though minute sulcation quite as strongly as *Cryptoptilum antillarum*. This sulcation appears to be found in nearly all the species of the present group, and although

in *Glaphyropus* and *Oligacanthopus* this may be said to be absent, under a powerful microscope traces of such a suture may be found. *Liphoplus* and *Arachnocephalus* are said to have the protuberance so distinctly sulcate that, when viewed from above, the interantennal protuberance can be seen to be divided by a sulcus which separates this part into two distinct lobes. In all of the other known genera a distinct but more or less subobsolete sulcus exists. The variation in individual opinion in considering this type sulcate or non-sulcate has led to much confusion.

Specimens Examined.—1 ♀.

Miami, Fla.; Feb. 6, 1904; (H.); 1 ♀. (TYPE) [Hebard Collection.]

HOPLOSPHYRUM[47] new genus.

1868. *Mogoplistes* Scudder (not of Serville, 1839), Proc. Bost. Soc. Nat. Hist., XII, p. 142.
1874. *Mogoplistes* Saussure, Miss. Sci. Mex., Rech. Zool., VI, p. 423 (in part).
1877. *Mogisoplistus* Saussure, Mélang. Orth., II, p. 463 (in part).
1897. *Ectatoderus* Saussure (not of Guérin, 1849), Biol. Cent.-Amer., Orth., I, p. 230.
1902. *Ectatoderus* Scudder (not of Guérin, 1849), Proc. Davenp. Acad. Sci., IX, p. 58.

Genus includes three species. GENOTYPE—*Hoplosphyrum occidentale* [*Mogoplistes occidentalis*] (Scudder).

The genus *Hoplosphyrum* is erected to include forms which are closer to *Ornebius* Guérin than to any other genus, but from which individuals of this genus can be readily separated by the elongate median spur of the caudal tibiæ and the very peculiar non-dilated apex of the ovipositor. The form of the pronotum and the apparent tegmina of the males show that they are not at all related to true *Ectatoderus*, while the presence of well-developed tegmina in the male, the ovipositor structure in the female, and the spur proportions are readily appreciable characters to differentiate the new genus from *Mogoplistes*.

Generic Description.—Form hardly depressed, compact, surface clothed with scales; pronotum little produced caudad in male, in general subquadrate dorsad; tegmina absent in female, well-developed and projecting caudad of pronotum in male.

Head little produced cephalad; interantennal protuberance with slightest trace of vertical division. Pronotum of male subdepressed,

[47] From ὅπλον, arm or weapon, and σφυρόν, ankle; in allusion to the long spurs on the distal extremities of the caudal tibiæ.

subquadrate or slightly longer than wide, narrowing but little cephalad, cephalic margin arcuato-emarginate, caudal margin arcuato-truncate; of female transversely arcuate, subquadrate in form, cephalic margin arcuato-emarginate, caudal margin emarginato-truncate; disk in both sexes cephalad with paired pyriform impressed outlines flanked cephalad and caudad by single subcallous points. Tegmina of male extending caudad of pronotum a distance equal or subequal to the pronotal length, broad, distal margin arcuate, tympanum fully developed, lateral field deep. Ovipositor cylindrical, straight or but little arcuate, apex simple, not differentiated from the shaft, unarmed, immediate apex acute. Subgenital plate of both sexes with the distal margin not excised, this plate in females compressed. Cerci of both sexes elongate, tapering. Cephalic tibiæ with the cephalic face with a distinct tympanum. Caudal femora dilated; caudal tibiæ straight, robust, deplanate dorsad, serrate dorso-laterad, with three pair of distal spurs, the dorso-internal shorter than the ventro-internal, the medio-internal elongate, reaching to the middle of the metatarsus; caudal metatarsus compressed, sulcate dorsad, strongly serrate on both dorsal margins, armed disto-laterad with spurs which cover the proximal portion of the terminal joint of the tarsus.

Distribution in North America.—Extending from southern New Mexico to the southern slopes of the Sierra Madre in California, southward to the Cape Region of Lower California, and also in the state of Guerrero, Mexico.

Key to Hoplosphyrum, New Genus.

A. Terminal palpal joint elongate, subtubiform, the distal margin very obliquely subtruncate.
  B. Pronotum of male with cephalic width contained one and one-half times in the greatest length of the same, somewhat produced caudad; lateral lobes of male pronotum obliquely arcuato-emarginate caudad; ovipositor slender, subequal to the caudal femora in length..... *occidentale* (Scudder).
  BB. Pronotum of male with cephalic width contained very slightly more than once in the greatest length of the same, subquadrate; lateral lobes of male pronotum obliquely subtruncate caudad, not at all arcuato-emarginate; ovipositor more robust, shorter than the caudal femora, *boreale* (Scudder).
AA. Terminal joint of palpi broader, ovate .... *aztecum* (Saussure).

Hoplosphyrum occidentale (Scudder).

1868. *Mogoplistes occidentalis* Scudder, Proc. Bost. Soc. Nat. Hist., XII, p. 142. [Cape St. Lucas, Lower California.]

1874. *Mogoplistes occidentalis* Saussure, Miss. Sci. Mex., Rech. Zool., VI, p. 424. [Lower California.]

1877. *M[ogisoplistus]*? *occidentalis* Saussure, Mélang. Orth., II, p. 469. [Lower California.]

1896. *Mogoplistes occidentalis* Scudder, Proc. Bost. Soc. Nat. Hist., XXVII, p. 215.

1902. *E[clatoderus] occidentalis* Scudder, Proc. Davenp. Acad. Sci., IX, p. 59.

Types:[48] 2 ♀; Cape St. Lucas, Lower California. [Scudder Collection.]

Description of Lectotype here Selected.—Size large for the genus; form elongate fusiform. Head rather small, depth subequal to greatest width, depressed dorsad, moderately protuberant between the antennal bases, without an appreciable vertical sulcus; eyes subpyriform, somewhat prominent laterad when viewed from the cephalic aspect. Maxillary palpi with the distal joint very elongate, slightly longer than the preceding joint, trumpet shaped, the distal margin very obliquely truncate, the length of the truncation contained over twice in the next shortest side. Pronotum subdeplanate dorsad, in proportions subquadrate, the lateral lines of the disk weakly subconvergent cephalad; cephalic margin strongly arcuato-emarginate, the head well seated in the same, caudal margin subtruncate, very faintly and very broadly subemarginate mesad; dorsum passing into the lateral lobes without lateral carinæ, but with appreciable angles caudad; lateral lobes with the greatest depth contained about three times in the greatest (dorsal) length of the same, ventral margin of lobes straight, becoming obliquely subarcuato-emarginate in the caudal half. Tegmina absent. Abdomen slightly deplanate dorsad, elliptical in outline. Subgenital plate small, subrostrate, very slightly arcuato-emarginate mesad. Ovipositor equal in length to the abdomen, subequal in length to the caudal femur, of moderate depth, slightly arcuate dorsad in the proximal third, thence straight, apex with very small impressed puncta. Cerci elongate, tapering. Cephalic tibiæ with a distinct but small elliptical tympanum on the cephalic face. Median limbs similar in proportions to the cephalic. Caudal femora moderately

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[48] Both of the types have lost all of their limbs, and the characters of these parts are supplied from practically topotypic material.

inflated, the greatest depth contained slightly more than two and one-half times in the length of the same. Caudal tibiæ compressed, V-shaped in section, the dorsum deplanate, nonsulcate, the margins elevated and closely serrate, dorso- and ventro-external distal spurs subequal in length, medio-external nearly twice the length of those dorsad and ventrad of it, internal spurs all longer than the external spurs and as in the generic diagnosis; caudal metatarsus armed on the dorso-internal margin with eight to nine spines, on the dorso-external margin with nine to ten spines.

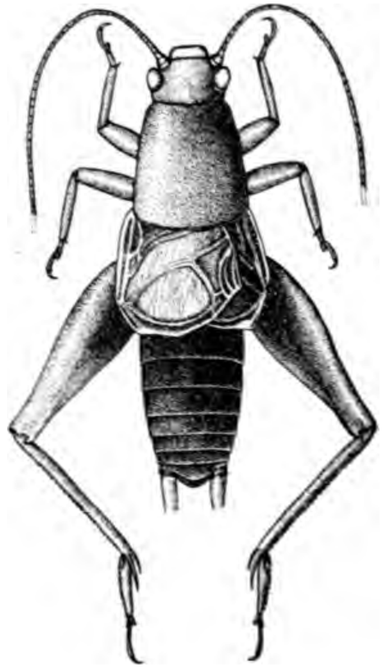

Fig. 24.— *Hoplosphyrum occidentale.* Dorsal view of allotype. (× 4.)

Allotypic ♂ here selected; San José del Cabo, Lower California. [Hebard Collection.]

Description of Allotype.—Agreeing with the female lectotype except in characters here mentioned. Pronotum of male more produced caudad and more ampliate in the same direction, the cephalic width contained one and one-half times in its greatest length, the greatest caudal width subequal to its length; cephalic margin as in female, caudal margin strongly arcuate laterad, arcuato-truncate mesad; lateral lobes as in the female. Tegmina well developed for this group, projecting caudad of the pronotum a distance which at its greatest is subequal to the greatest length of the pronotum, broad, the width of the dorsal field of a single tegmen subequal to the greatest width of the pronotum; lateral field deep, slightly less than half the width of the dorsal field; distal extremity of dorsal field well arcuate; speculum of tegmina subequal in width to the cephalic margin of the pronotum. Subgenital plate with the distal margin complete.

Measurements (in millimeters).

	ALLOTYPE. San José del Cabo, L. Cal. ♂	TYPE. Cape St. Lucas, L. Cal. ♀
Length of body	14.3	13.2
Length of pronotum[49]	4.5	4.
Caudal width of pronotum	4.2	4.
Length of caudal femur	7.5	......
Greatest width of caudal femur	2.9	......
Length of ovipositor	......	7.8

	Average of series. ♂♂	♀♀
Length of body	12.7 (12. –14.5)	12.8 (11.5–14.)
Length of pronotum[49]	4.1 (4. – 4.5)	3.8 (3.5– 4.)
Caudal width of pronotum	4.1 (4. – 4.5)	3.9 (3.5– 4.2)
Length of caudal femur	7.3 (7.2– 7.5)	7.6 (6.7– 8.2)
Greatest width of caudal femur.	2.9 (2.9– 3.)	3.1 (2.9– 3.3)
Length of ovipositor	......	7.6 (7. – 8.)

Color Notes.—General shade of females varying from tawny ochraceous to vandyke-brown, the abdominal segments frequently darker proximad than is the general coloration. General color of head and

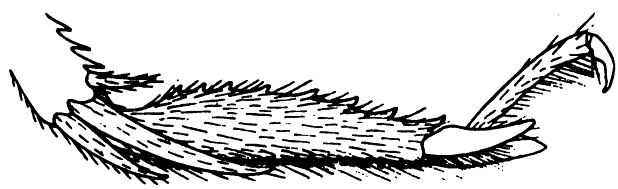

Fig. 25.—*Hoplosphyrum occidentale.* Internal face of caudal metatarsus and internal tibial spurs. (Greatly magnified.)

pronotum of male varying from cinnamon-rufous to hazel, the pyriform pronotal impressions umber, some incomplete concentric markings on the occiput of the same color. Abdomen of male deep chocolate, the margins of the segments very narrowly lined with whitish; the overlying scales of the abdomen bistre with points of ecru-drab, the latter color predominating in the marginal scales. Eyes very pale drab; palpi seal-brown; antennæ raw umber. Pronotum with the lateral lobes seal-brown. Tegmina of male broccoli-brown clouded with seal-brown, particularly toward the distal margin, veins more or less prominently lined with grayish-white; lateral field of tegmina

[49] Along lateral angle, as in the female the median length is less than the lateral.

with the base color seal-brown. Cephalic and median limbs seal-brown; caudal limbs burnt umber becoming seal-brown on the tarsi. Ovipositor raw umber.

All of the specimens before us appear to have been immersed in alcohol at some time, and in consequence the color description is not

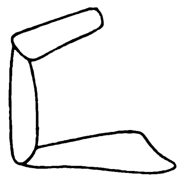

Fig. 26.—*Hoplosphyrum occidentale*. Maxillary palpus. (Greatly magnified.)

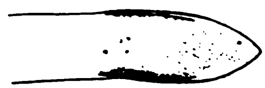

Fig. 27.—*Hoplosphyrum occidentale*. Apex of ovipositor. (Greatly magnified.)

as satisfactory as could be desired. In nearly all of the specimens the scales have been almost completely abraded and in but one specimen is there enough left to give an idea of the mass coloration of the scales.

Distribution.—With all the known material of this species before us, we can only give its distribution as the Cape Region of Lower California. San José del Cabo and Cape St. Lucas are the localities.

Synonymy.—Originally described and for years known only from two typical females, the acquisition of males of the allied *boreale* enabled Scudder to remove the species from *Mogoplistes*, in which he had erroneously placed it at the time of the original description. Unfortunately, he placed it in *Ectatoderus* Guérin, a genus which has no apparent tegmina in the male and an immensely long pronotum in the same sex. In consequence we have been compelled to erect the genus *Hoplosphyrum* to receive the three forms here placed in it.

Specimens Examined.—9; 3 males and 6 females.

Cape St. Lucas, Lower California; 2 ♀. (Types) [Scudder Collection.]

San José del Cabo, Lower California; 3 ♂, 4 ♀. [Hebard Collection.]

Hoplosphyrum boreale (Scudder).

1902. *Ectatoderus borealis* Scudder, Proc. Davenp. Acad. Sci., IX, p. 58, pl. IV, fig. 4.[40] [La Cueva and Dripping Springs, Organ Mts., New Mexico; Julian, San Diego County, California.]

1905. *Ectatoderus borealis* Baker, Invertebr. Pacif., I, p. 79. [Claremont, California.]

1909. *Ectatoderus borealis* Rehn and Hebard, Proc. Acad. Nat. Sci. Phila., 1909, p. 172. [Between Alamogordo and Dry Cañon, Otero County, New Mexico; Florida Mts., New Mexico.]

This species differs from *H. occidentale* in having the cephalic

width of the male pronotum contained only slightly more than once in the greatest length of the same, and in consequence the pronotal disk is more quadrate; the lateral lobes of the male pronotum are obliquely subtruncate, but not at all emarginate, and the ovipositor is more robust and is shorter than the caudal femora.

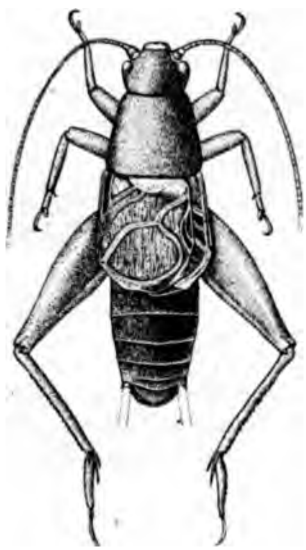

Fig. 28.—*Hoplosphyrum boreale*. Dorsal view of lectotype. (× 4.)

TYPES: 1 ♂, 1 ♀; La Cueva, N. M.: 1 ♂; Julian, Cal. [All Scudder Collection.]

Lectotype here selected: ♂; La Cueva, Organ Mountains, New Mexico, September 4. (C. H. T. Townsend.) [Scudder Collection.][50]

Description of Lectotype.—This specimen differs from the allotypic male of *occidentale* in the characters here given. Size smaller, head subcompressed, the depth considerably greater than the greatest width (across eyes); eyes less protuberant, hardly projecting beyond the general line of the head. Pronotum with the cephalic width contained slightly more than once in the length of the dorsum, lateral margins moderately expanding caudad, caudal margin of the disk less rounded laterad than in *occidentale* and in consequence the caudal margin is straighter; lateral lobes of the pronotum deeper than in *occidentale*, ventro-caudal margin without any arcuate-emargination, more decidedly oblique truncate. Tegmina, on account of the reduced pronotum, appearing to be longer and more ample than in *occidentale*, in general form and proportions, however, being very similar; the greatest width of a single tegmen is slightly less than the caudal width of the pronotum; speculum of tegmina distinctly wider than the cephalic width of the pronotum and subequal to the median length of the same. Caudal femora less inflated than in *occidentale*; caudal metatarsus armed dorsad with eight internal and ten external spines.

[50] The originally figured specimen is the female from Dripping Springs (*vide infra*), the condition of the individual fully agreeing with the figure. As this specimen was subsequently received by Scudder and is not one of the listed type series, it cannot be regarded as the lectotype.

Allotypic ♀ here selected. Data the same as the type, except date which is September 5.

Description of Allotype.—Closely resembling the same sex of *occidentale*, differing only in the characters here indicated. Size smaller. Head with the proportions of the same and prominence of eyes as in male sex. Pronotum subquadrate, the greatest caudal width slightly greater than the length of the same; margins as in *occidentale;* lateral lobes as in the male. Ovipositor more robust and shorter than caudal femur. Caudal limbs somewhat less robust.

Measurements (in millimeters).

	TYPE. La Cueva, N. M.	ALLOTYPE. La Cueva, N. M.	Julian, Cal.	San José del Cabo, L. Cal.	La Cheeparosa, L. Cal.
	♂	♀	♂	♂	♂
Length of body	12.7	13.	10.5	8.6	12.3
Length of pronotum	3.	3.	2.9	2.4	3.3
Caudal width of pronotum	3.2	3.4	3.1	2.7	3.4
Length of tegmen	4.5	......	4.1	3.2	4.
Length of caudal femur	7.	7.1	6.	....	6.
Greatest width of caudal femur	2.5	2.4	....	......	2.2
Length of ovipositor	......	6.5	......	......	....

	Los Angeles Co., Cal.	Florida Mts., N. M.
	♀	♀
Length of body	9.5	12.
Length of pronotum	2.4	2.9
Caudal width of pronotum	2.8	3.2
Length of tegmen	......	....
Length of caudal femur	5.1	7.
Greatest width of caudal femur	2.	2.4
Length of ovipositor	4.8	6.2

	Los Angeles and Los Angeles Co., Cal. Average of series. ♂♂	♀♀
Length of body	9.3 (8.5–10.)	10.2 (9.5–11.)
Length of pronotum	2.4 (2.3– 2.6)	2.5 (2.3– 2.8)
Caudal width of pronotum	2.8 (2.6– 3.)	2.9 (2.8– 3.1)
Length of tegmen	3.2 (2.9– 3.8)	....
Length of caudal femur	5.3 (5.2– 5.5)	5.6 (5.1– 6.3)
Greatest width of caudal femur	2. (2.)	2. (1.9– 2.2)
Length of ovipositor	....	5.1 (4.6– 5.5)

Color Notes.—General tone of more or less abraded specimens varying from cinnamon to ochraceous, the abdomen generally seal-brown, but in a few specimens[51] the abdominal coloration is no darker than the general tone. Eyes varying from broccoli to clove-brown, palpi varying in similar fashion. Lateral lobes of the pronotum wholly seal-brown, the dorsal line of the color mass more sharply defined in some than in other specimens. Abdominal segments in the majority of specimens narrowly margined with whitish; ovipositor ferruginous; cerci buffy, darkening distad. Limbs buffy,[52] but as the overlying scales are more generally present on the limbs than on the rest of the body and in color are raw umber, the general shade is dark, with, however, a more or less distinct paler pregenicular annulus; caudal tibiæ with the scales colored in such a fashion that there is a broad median pale annulus and another extremely narrow one immediately distad of the genicular extremity, the remainder of the tibial scales being seal-brown. In the specimens sufficiently abraded on the dorsum to enable one to ascertain the color of the scales, it is seen that pale buff-gray is the covering color, while in some specimens regularly placed patches of umber scales are found on the margins of the abdominal segments.

Distribution.—From Southern New Mexico (Alamogordo and Organ Mountains) west to Southern California, north as far as the southern slopes of the Sierra Madre (Claremont), thence south to the Cape region of Lower California. Nothing whatever is known of the distribution of the species in northern Mexico, and we have no record of its occurrence in Arizona. The highest elevation (of which we have record) at which the species has been taken is Dripping Springs, N. M., at an altitude of 5,800 feet above sea level.

Biological Notes.—The only knowledge concerning the habits of this species is the fact that the Alamogordo specimen was taken by the authors from a dead yucca.

Remarks.—The present species is one which varies much in size, New Mexican individuals surpassing all others in this respect except Sierra Laguna, Lower California, specimens. Such variation is not

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[51] These specimens have not had their coloration lightened by alcoholic immersion. A number of other individuals which have at some time been immersed in alcohol are equally pale on the abdomen, but we have not considered such specimens in drawing up the above notes.

[52] In specimens which have been in alcohol the cephalic and median limbs are much darker, seal-brown in fact, but this does not seem to be the natural coloration.

correlated with definite regions, as San José del Cabo representatives are as small as any seen, while the Los Angeles County, California, specimens are all of very small size. The Lower California individuals vary considerably from the typical New Mexican phase, approaching *occidentale* in the shape of the head; some specimens having the proportions of the latter as in *occidentale*, but in such cases the proportion of the pronotum in the male, the rather slenderer caudal femora in both sexes, and the distinctly shorter and more robust ovipositor in the female will serve to associate properly the individuals. The number of spines on the dorsal margins of the caudal metatarsi varies considerably, the external margin having from six to nine and the internal seven to twelve distinctly indicated. The number of these spines is in no way correlated with the locality. The tympanum is clearly indicated on the cephalic face of the caudal tibiæ in all the adults examined, although varying considerably in size and exact shape, but it is not present in nymphal specimens. The cerci vary in length in this species much as in *Cryptoptilum antillarum*. The subgenital plate in the male is weakly subtruncate in several individuals, but its normal form is similar to that of *occidentale*.

Specimens Examined.—40: 13 males, 23 females and 4 nymphs.

Dripping Springs, Organ Mts., N. M.; Sept., 1899; (Cockerell); 1 —. [U. S. N. M.]: (Cockerell); 1 ♂, 1 ♀. [Scudder Collection.]

La Cueva, Organ Mts., N. M.; Sept. 4, 5; (C. H. T. Townsend); 1 ♂, 1 ♀. (TYPES) [Scudder Collection.]

Alamogordo to Dry Cañon, N. M.; July 13, 1907; (R. and H.); 1 ♀ n. [Hebard Collection.]

Florida Mts., N. M.; (Pilsbry); 2 ♀. [A. N. S. P.]

California; 1 ♀. [U. S. N. M.]

Los Angeles County, Cal.; (Coquillett); 2 ♂, 4 ♀. [U. S. N. M.]

Los Angeles, Cal.; (Coquillett); 1 ♂, 2 ♀. [U. S. N. M.]: 1 ♂. [Hebard Collection.]

Claremont, Cal.; (C. F. Baker); 1 ♂. [A. N. S. P.]

Julian, San Diego Co., Cal.; July; 1 ♂. (TYPE) [Scudder Collection.]

Lower California; 1 ♂, 3 ♀. [Hebard Collection.]

Sierra Laguna, L. Cal.; (Eisen); 1 ♂, 3 ♀. [*ibid.*]

La Joya, Sierra Laguna, L. Cal.; (Eisen); 1 ♀ n. [*ibid.*]

La Cheeparosa, L. Cal.; 1 ♂, 1 ♀ n. [*ibid.*]

San Lazaro, L. Cal.; Sept., 1894; 1 ♀. [*ibid.*]

Sierra el Toste, L. Cal.; Sept. 23; (Eisen); 1 ♂. [*ibid.*]

San José del Cabo, L. Cal.; 1 ♂, 5 ♀, 1 ♀ n. [*ibid.*]

Hoplosphyrum aztecum (Saussure).

1897. *Ectatoderus aztecus* Saussure, Biol. Cent. Amer., Orth., I, p. 230, pl. XI, figs. 35, 36. [Chilpancingo, Guerrero, Mexico, 4,600 feet.]
1905. *Ectatoderus aztecus* Baker, Invertebr. Pacif., I, p. 79. [Acapulco, Guerrero, Mexico.]

As far as can be determined from the description, this species can be readily separated from the other species of this genus, to which it undoubtedly belongs, by the ovate terminal palpal joint.

TYPE: ♂; Chilpancingo, Guerrero, Mexico, elevation 4,600 feet. (H. H. Smith.) [*Biologia* Collection in British Museum.]

Description of Type.—"Somewhat thickened, fuscous. Head suborbicular, lightly convex, a fulvous obsolete transverse facial line and an irregular fulvous line on each side above the eyes. Antennæ fuscous, bases paler. Eyes broadly elliptical or subovoid, hardly attenuate above, internal margin above very subtlely incised. Terminal palpal joint a little broader, ovate. Pronotum as long as wide, deplanate, anteriorly not strongly coarctate; anterior margin sinuate, posterior transverse, scarcely arcuate; upper part seen from above castaneous, broadly flavo-fulvous on the margins of both sides, lateral lobes black. Disk marked above on both sides with two crassate black puncta and on each side between these an intercalate pyriform depression, showing exteriorly acute elevated margins. Elytra parallel on dorsum, leaving the apex of the abdomen exposed, shaded with dull testaceous and fuscous lines, posterior margin arcuate; regularly vittate with fuscous at the margin. Speculum much broader than long, with elevated lines, the anterior angle right- or obtuse-angulate; anal rami three. Lateral field very wide, luteous, with two to three longitudinal fuscous lines, the second the widest; inferior margin angulate before the middle. Feet compressed; anterior and intermediate fuscous, coxæ, knees and tarsal articulations testaceous; metatarsi moderately long. Posterior femora heavy, fusco-testaceous, apically fuscous. Posterior tibiæ moderately broad, fusco-rufescent, apically more fuscous, above broadly canaliculate, the margins heavily denticulate. Internal intermediate spur fairly elongate; upper minute. Tarsi fuscous; posterior metatarsus elongate, above armed with many teeth. Abdomen brownish-black, beneath fusco-testaceous. Cerci rather long, rufous, bases thickened. Last dorsal segment narrow, testaceous. Supra-anal plate elongate-trigonal, apex rounded. Subgenital plate transverse, margin subarcuate, black.

"♂. Length of body 6.8; pronotum 2.2, width 3; elytra beyond pronotum 2.7, width 3.2; posterior femur 4.8 millimeters."

Remarks.—No specimens of this species are available for study. We have included the species to make our study of the genus complete for the forms found north of Panama.

Genus **LIPHOPLUS** Saussure.

1877. *Liphoplus* Saussure, Mélang. Orth., II, pp. 456, 483.

GENOTYPE (selected by Kirby): *Liphoplus novaræ* Saussure.

We do not feel positive that the following species is really a member of the genus *Liphoplus*, which elsewhere is found only in the Polynesian, Indian and Malagasian regions. However, as the original description specifically agrees with most of the generic characters which Saussure gave as diagnostic of his genus, we have no alternative, in the absence of material, but to retain it in *Liphoplus*. No mention is made of the absence of a tympanum on the cephalic face of the cephalic tibiæ, which absence is considered an important generic character in the original description of the genus, but this omission is rather discounted by the figure which shows no tympanum, thus agreeing with true *Liphoplus*. The interantennal protuberance is described and figured as distinctly divided.

Generic Description.—"Body pubescent, the females apterous, the males supplied with tegmina. Head as in *Arachnocephalus*, showing a protuberance divided by a sulcus.

"Pronotum in the males produced posteriorly over the metanotum, as in *Ectatoderus*, the caudal margin arcuate; less produced in the females. Anterior tibiæ having the internal faces supplied with a small tambourine. Tegmina of males short, membranous, supplied with a complete tambourine, but sometimes more or less obsolete.

"This genus is to us but imperfectly known. The body is very pubescent, but we presume that it should be likewise more or less scaled in fresh and well-preserved individuals. The elytra of the males show in their tambourines certain analogies to those of the *Phalangopsini*, the first vein being angulate.

"*Liphoplus* differs from *Arachnocephalus* in the anterior tibiæ being furnished with a tambourine, and in their winged males; from *Ectatoderus* in their facial protuberance being distinctly divided."

Distribution in North America.—State of Guerrero, Mexico.

Liphoplus mexicanus Saussure.

1897. *Liphoplus mexicanus* Saussure, Biol. Cent. Amer., Orth., I, p. 231, pl. XI, fig. 37. [Amula, Guerrero, Mexico.]

TYPE: ♂; Amula, Guerrero, Mexico, elevation 6,000 feet. (H. H. Smith.) [*Biologia* Collection in British Museum.]

Description of Type.—"Rufo-testaceous, depressed. Antennæ of

the same color. Head and pronotum covered with grayish scales. Facial scutellum much swollen, divided by a sulcus. Pronotum large, depressed, much narrowed anteriorly, much dilated posteriorly, posterior margin transversely arcuate. Elytra surpassing the pronotum very much, leaving the last two abdominal segments exposed, broader than pronotum, testaceous, flat; lateral field deflexed, narrow, reflexed inferiorly, divided by a thick, luteous longitudinal vein, marginal half (base and extremity excepted) blackish; dorsal field very broad, posterior margin broadly rounded, margins reddish; speculum very large, subtrigonal, posterior margin arcuate, anterior angle hidden under pronotum, entire disk irregularly folded like a fan and divided by a rectangular vein. Feet reddish, covered with whitish scales; femora heavy. Posterior tibiæ mildly arcuate, above flat, acutely rounded, thickly armed with minute teeth. Internal spurs: intermediate equal to one-third of the metatarsus; upper short, shorter than lower, equalling or exceeding half the length of the intermediate. External spurs very small: upper little longer than lower, removed from the intermediate spur. Metatarsus posteriorly compressed, having two series of denticulations above. All of the tarsi black at apex. Apical portion of abdomen attenuate, black. Supra-anal plate minute, transverse, deflexed, divided by a sulcus. Subgenital plate elongate, covered with hairs, the apex forming two denticulations. Cerci long, reddish.

"♂. Length of body 9; pronotum 3.7, width 3; tegmina beyond pronotum 2.9, width 3.8; caudal femora 5 millimeters."

Remarks.—No specimens of this species are available for study. We have included the genus and species to make our study of the group complete for the forms found north of Panama.

ON THE ORTHOPTERA FOUND ON THE FLORIDA KEYS AND IN EXTREME SOUTHERN FLORIDA. I.

BY JAMES A. G. REHN AND MORGAN HEBARD.

It has been the desire of the authors for some time to determine what species of Orthoptera were to be found throughout the winter in the subtropical area of southern Florida. With this end in view, the junior author visited the region in the latter part of March, 1910, as it seemed evident that this would be the time when species would have entirely disappeared, should they succumb to the colder weather in this region, while spring forms would, as a rule, not have reached maturity. The facts obtained would indicate that a considerable proportion of the species of this region are in evidence throughout the winter, though probably in considerably reduced numbers. The amount of this reduction cannot be stated at present, as insufficient work has been done in this region during the summer. The families Mantidæ and Tettigoniidæ, however, alone seem to be severely affected by the cold, and the few specimens taken which belonged to these families were either most battered remnants of the past summer or the first freshly emerged individuals of the spring brood. Nymphs of a number of interesting species were far more abundant than adults of the same, while nymphs of several species plainly unknown to the United States were taken, unfortunately in such an early stage of development as to make determination impossible. It is the intention of the authors to do considerable work in southern Florida during the summer of the present year, and not only is it hoped that adults of these very interesting species may be secured, but also that the publication of the results, when compared with those given in the present paper, will indicate the difference between the abundance of forms in the summer and winter throughout the region.

The following table will indicate the comparative abundance of forms as found just before the appearance of the spring forms.

Family.	Number of species.	Very abundant.	Abundant.	Small numbers.	Rare.	Very rare.	Nymphs only.
Forficulidæ	5	1	3	1	—	—	—
Blattidæ	9	—	1	2	1	3	2
Mantidæ	2	—	—	—	—	—	2
Phasmidæ	3	—	1	—	—	1	1
Acrididæ	23	1	11	6	1	1	3
Tettigoniidæ	5	—	—	1	1	3	—
Gryllidæ	18	2	4	5	1	5	1

The number of specimens taken on the trip of March, 1910, is thirteen hundred and fifteen, and includes sixty-one species. The authors have also examined and here recorded material from this region which was collected for the Brooklyn Museum of Arts and Sciences during the latter part of November, 1911. All of the material in the United States National Museum from southern Florida has been placed at the disposal of the authors through the kindness of Mr. A. N. Caudell, and the specimens which had not been previously considered are recorded in the present paper. Miscellaneous material in the Hebard Collection and the Academy of Natural Sciences of Philadelphia from this region, and the collections made by the junior author in January and February, 1903 and 1904, in southern Florida, have also been examined and treated in the present paper, when such action has been thought advisable. All of the material considered in the present paper is in the Hebard Collection and that of the Academy of Natural Sciences of Philadelphia, with the exception of these specimens which have B. I. (Brooklyn Institute of Arts and Sciences), or U. S. N. M. (United States National Museum) in brackets after the records. We wish to extend our thanks to Mr. W. S. Blatchley for the loan of the types of his *Eritettix sylvestrus*, which enabled us to solve definitely the problem involved. The total number of specimens treated in the present paper is fourteen hundred and eighty-six, which includes sixty-three species; of these one new species and two new geographic races are described, while one circumtropical species is recorded from the United States for the first time.

FORFICULIDÆ.

Anisolabis annulipes (H. Lucas).

Long Key, Fla., March 17, 1910; 1 ♀.
Key West, Fla., March 15, 16, 1910; 5 ♂, 12 ♀.

In the series before us we find the femoral annuli lacking in two specimens and weakly indicated in a number of others. The specimens from Key West were taken from under boards in a vacant field, from under coquina boulders on coquina sand on the beach and also under coquina boulders on fine sand a little back from the beach. Along the beach this form was much the less plentiful of the two species of the genus there found.

Anisolabis maritima (Gené).

Long Key, Fla., March 13, 17, 1910; 4 ♂, 11 ♀.
Key West, Fla., March 15, 16, 1910; 24 ♂, 24 ♀: November 21, 1911 (Englehardt); 1 ♀ [B. I.].

The specimens from Long Key were all found on the wet ground under heads of prostrate cocoanut palms which had been saturated with salt water and were thoroughly decayed. These specimens when captured possessed an exceedingly disagreeable odor suggestive of decomposition. One specimen at Key West was taken from under boards in a vacant field where most of the specimens of *Anisolabis annulipes* were found, but the others of the series were all taken from under coquina boulders scattered along the beach just above the usual high-water mark. It is among these boulders about half way up the beach that the beach plant, *Borrichia fontescens*, grows abundantly. In this situation *Anisolabis maritima* was exceedingly plentiful, and when disturbed individuals of a colony were seen to run about with abdomen curved upward and forceps wide open, ready to administer a vigorous pinch.

Labidura bidens (Olivier).

Key West, Fla., March 15, 16, 1910; 13 ♂, 9 ♀, 1 ♀ n: November 21, 1911 (Englehardt); 1 ♂ [B. I.].

We use Olivier's name in conformity with our previous papers, although we are by no means convinced of the specific distinction of Floridian and West Indian specimens from true *Labidura riparia*. Burr[1] has tentatively allowed *bidens* to have a place in his "forms" of the *riparia* group. This species was found in the same beach environment as the last, usually in twos and threes, and individuals were exceedingly repulsive owing to the fact that they emitted an odor suggesting carrion, but even more nauseating. This odor seemed not to originate from an ejected secretion, but from the oily surface of the body. The great forceps of this species are exceedingly weak compared with those of *Anisolabis maritima*, although individuals made themselves appear very formidable when molested.

Labia curvicauda (Motsch).

Long Key, Fla., March 13, 17, 1910; 50 ♂, 78 ♀, 4 n.

This species, which has never before been recorded from the United States, was found in numbers in the dying tops of cocoanut palms at the white base of the fronds where these were moist. None were ever found at the dry bases of the dead fronds, but when these were torn off, the living, hard, white base of each underlying frond, already dead and dry except at that point, would usually expose several specimens. Sometimes several adults would be exposed, sometimes a small colony of very young insects, and once a female

[1] *Genera Insectorum, Derm.*, p. 37.

guarding a tiny heap of eggs which she immediately started to remove, carrying two or three eggs at a time to a spot an inch away. These earwigs were often found near nests of a small stocky red ant, which species did not seem to interfere with them at all. It was possible to obtain so large a series owing to the fact that the hurricane of the previous summer had blown down quantities of cocoanut palms; these prostrate or half-prostrate trees were examined and about half were found to contain specimens of this earwig. In the large series before us we find the length of the females to be from 4 to 5 mm., and that of the males from 4 to 5.5 mm.; a few other specimens would exceed this maximum, but are found to be squeezed to an unnatural length. The great majority of adults in the series are very near 4.5 mm. in length. Among the specimens taken are two females which had but recently reached maturity and are colored uniformly pale wood-brown. This species is found around the world in tropical latitudes; it was described from the Nura Ellia Mountains of Ceylon.

Prolabia unidentata (Beauv.).[2]

Labia burgessi Sc.
Labia guttata Sc.

Miami, Fla., March 27, 28, 1910; 7 ♂, 7 ♀, 2 ♀ n.
Homestead, Fla., March 17–19, 1910; 3 ♂, 6 ♀, 1 ♀ n.

One male specimen from Miami has the usual median tooth on the internal margin of the forceps lacking, while the other individuals of that sex show this tooth varying from a very blunt to a strongly marked protuberance. We have followed Burr in using this specific name for the wingless form generally called *burgessi* Scudder. All of the present series lack wings. The specimens were all taken from under the bark of dead pine logs in the pine woods.

BLATTIDÆ.

Ischnoptera deropeltiformis (Brunner).

Homestead, Fla., March 17–19, 1910; 2 ♂, 1 ♀, 1 ♂ n, 2 ♀ n.

Both of the adult males have the tegmina 15 mm. in length, this being slightly smaller than the measurements previously given by the authors as the minimum for the species. The adult female, on the other hand, is slightly above the average size. In all the specimens the femora and tibiæ are similarly colored. This species, previously recorded as far south as Miami, Fla., was found under

[2] Burr, *Proc. U. S. N. M.*, Vol. XXXVIII, pp. 451, 452, 1911.

rubbish about a small cultivated "pot-hole" in the pine woods, excepting the adult female, which was taken from under a board far out on the everglades. This species is distinctly geophilous and appears to prefer damp surroundings.

Neoblattella[3] **adspersicollis** (Stål).

Homestead, Fla., March 18, 1910; 1 ♂.

The only previous record of this species in the United States is the authors' report of its occurrence at Miami, Fla.[4] The specimen taken at Homestead was captured two miles westward in the pine forest. All of the specimens secured at Miami were taken in the town, and it was therefore a question whether the species was not recently introduced. The capture of the present specimen, well out in the untouched forest, would indicate that the species is indigenous to this region. There are four specimens of this species in the National Museum from Dade County, Florida.

Ceratinoptera diaphana (Fabr.).

Long Key, Fla., March 13, 1910; 2 n.

This striking species, easily recognized in the immature condition, has been recorded from Key West by the authors.[5] These are the only records of the species occurring within the United States. The specimens at present under consideration were taken from under the loose dry fibres near the head of a standing cocoanut palm. The specimen from Key West, an adult female, was taken from under a coquina boulder in heavy scrub.

Ceratinoptera lutea S. and Z.

Miami, Fla., March 20, 28, 1910; 1 ♂, 4 n.
Homestead, Fla., March 17–19, 1910; 1 ♂.
Key Largo, Fla., March 18, 1910; 1 ♀.
Long Key, Fla., March 13, 17, 1910; 4 ♂, 3 ♀, 4 n.
Key West, Fla., March 15, 16, 1910; 1 ♂, 4 ♀, 1 n.

All the adult specimens from the above localities have the tegmina failing to reach the apex of the abdomen by a considerable interval. Specimens from Georgia and North Carolina agree more fully with the original description in having the tegmina as long as the abdomen. The series from Long Key was captured by looking under dead petioles of the cocoanut palm lying on moist ground along the edges of pools of brackish water, while the specimens from Key West were

[3] *Vide* Shelford, *Entom. Monthly Mag.*, (2) Vol. XXII, p. 155.
[4] These *Proceedings*, 1905, p. 32.
[5] *Entomological News*, Vol. XXI, p. 103, 1910.

taken in dead dry grasses under boards in a vacant field on the edge of the city.

Phœtalia lævigata (Beauv.).

Key Largo, Fla., March, 1898, 1 ♀.[6]

This specimen, taken by C. L. Pollard, is in the U. S. N. M. Collection.

Eurycotis floridana (Walker).

Miami, Fla., March 28, 1910; 1 ♂: November 15, 1911 (Englehardt); 1 ♂ [B. I.].
Homestead, Fla., March 17–19, 1910; 4 n.
Long Key, Fla., March 13, 17, 1910; 9 n.
Key West, Fla., March 15, 16, 1910; 3 ♂, 7 ♀, 11 n.

Of the above adult specimens but one, a female, possesses decided light lateral borders on the pronotum, tegmina, and metanotum;[7] five others, however, representing both sexes, have more or less distinct indications of the same. These bars are not at all indicated in three of the five most immature individuals, but are very decided in the nymphs in the several stages immediately preceding maturity. The youngest specimens vary from uniform very dark seal-brown to the same color passing into maroon on the median portion of the thoracic segments, one of the latter coloration having fairly distinct lateral bars on a portion of the pronotum. One of the youngest Long Key nymphs is much paler than any of the others, being dark ferruginous with weakly indicated lateral bars. The antennæ of these quite juvenile individuals are ochraceous, slightly darker in some than in others. Apparently with the assumption of the pale lateral bars the head becomes paler, ferruginous in fact, and the antennæ are darkened. As growth progresses the head becomes burnt sienna, more or less clouded with seal-brown as found in the adult.

The specimens taken from the Florida mainland were all found in the pine woods under the dry bark of dead pine logs. On Long Key the series was taken from the dry fibres at the base of the heads of cocoanut palms; two adults seen escaped.

At Key West a large colony was discovered among boards lying on dry grass in a field, and several were captured upon turning over coquina boulders in the dense bush. When trying excitedly to

[6] See *Ent. News*, Vol. XXI, p. 103, 1910.

[7] For the synonomy of *Platyzosteria sabalianus* Scudder, *Platyzosteria ingens* Scudder, and *Periplaneta semipicta* Walker, see Rehn, *Trans. Am. Ent. Soc.*, Vol. XXIX, p. 277, 1903.

escape these insects emit from their anal extremities spurts of a white, acrid fluid which has a very pungent, stifling odor. They are called "Spanish roaches" by the natives of this region.[8]

There are three females and one nymph from Cape Sable, Fla., and one male from Sugar Loaf Key, Fla., taken in March, 1898, by O. F. Cook, in the National Museum.

Pycnoscelus surinamensis (Linn.).

Haulover, Fla., March; 1 adult [U. S. N. M.].
Miami, Fla., March 20, 1910; 3 ♂, 4 n: November 16, 1911 (Englehardt); 1 ♀ [B. I.].
Long Key, Fla., March 13, 17, 1910; 5 n.
Key West, Fla., March 15, 16, 1910; 1 ♀, 7 n.

This species is common under planks, stones, and other debris on the ground throughout this region. Two specimens were also found at Long Key in the dry fibres at the base of the petioles of a cocoanut palm.

Blaberus atropos (Stoll).

Key West, Fla.; 1 ♂.[9]

This specimen is in the collection of the Academy of Natural Sciences. The collection of the National Museum also contains a male specimen of this species taken at Key West, Fla., December 28, 1909, by Harris.

Plectoptera poeyi (Sauss.).

Key West, Fla., March 15, 1910; 1 ♀, 1 n.

The eight specimens collected at this locality on January 19, 1904,[10] were taken with ease in a short space of time by beating *Ilex cassine*, but on this last visit, though triple the number of these bushes were beaten vigorously, but one adult specimen of this roach was taken. Key West is the only definite locality in the United States from which this Cuban species has been recorded.

Chorisoneura plocea Rehn.

Key Largo, Fla., March 18, 1910; 1 ♀, 1 ♂ n.

The adult specimen measures as follows:

[8] For further notes on this species from Southern Florida see the present authors (these *Proceedings*, 1905, p. 32).

[9] The specimen was unintentionally recorded by the senior author in the *Entomological News*, Vol. XIX, p. 441, 1908, and by the authors erroneously as *Blaberus cubensis* Saussure in the *Entomological News*, Vol. XXI, p. 103, 1910.

[10] These *Proceedings*, 1905, p. 33.

Length of body	8.2 mm.
Length of pronotum	2. "
Greatest width of pronotum	3. "
Length of tegmen	7.5 "
Greatest width of tegmen	2.9 "

When compared with the Marietta, Ga., female recorded by the authors,[11] the Key Largo individuals are paler, more ochraceous, with the brown pronotal maculations reduced to a minimum, in this respect similar to the type.

The almost impenetrable jungle on Key Largo was examined, and in its depths the two specimens of this species were secured by beating the lower branches of gumbo limbo, other trees and the lower bushes and shrubs, among which latter are to be found such semi-tropical forms as *Ocotea catesbyana* and *Citharexylum villosum.*

MANTIDÆ.

Stagmomantis carolina (Johansson).

Long Key, Fla., March 13, 1910; 1 n.

Key West, Fla., March 15, 16, 1910; 1 n.

The specimen from Key West was beaten from the shrub *Ilex cassine.*

Gonatista grisea (Fabr.).

Dade City, Fla., September 14, 1907 (W. D. Furnley); 1 ♀ [U. S. N. M.].

Key West, Fla., March 15, 16, 1910; 4 n.: April 1 (Schwarz); 1 ♂ [U. S. N. M.].

Capron, Fla., April; 1 ♀ n. [U. S. N. M.].

These individuals from Key West are in a similar condition to those previously recorded by the authors from the same island. Two stages of development are represented in the four specimens. The specimens were taken in the same situation where they were previously found,[12] on the trunks of gumbo limbo trees.

The collection of the Academy contains an adult male from Tarpon Springs, Fla., taken November, 1909, by P. Cheyney, and an adult female from Texas without further data.

PHASMIDÆ.

Manomera tenuescens (Sc.).

Miami, Fla., March 28, 1910; 1 ♀, 11 n.

This series was taken by beating the clumps of wire grass and low

[11] These *Proceedings*, 1911, p. 586.
[12] These *Proceedings*, 1905, p. 33.

bushes growing on the very edge of the everglades. Five stages of development are represented among the eleven immature individuals. The adult female had just reached the mature stage and when captured was still in a soft condition. Considerable search failed to reveal more adults, and the indications are that in this region the last of March is the very earliest time for adults to appear.

Aplopus mayeri Caudell.

Key Largo, Fla., March 18, 1910; 1 n.

The specimen was beaten from a dense tangle of wild grape vines and other shrubbery growing in the heart of the jungle on Key Largo. So dense was the overhead vegetation in this situation that a condition of twilight existed throughout the day. While the specimen is quite immature, being but seventeen millimeters in length, it possesses sufficient in the way of characters to enable us to determine the species when compared with an adult paratypic pair from the type locality, Loggerhead Key, Florida. This record brings the range of this species close to the mainland of Florida, the only known locality other than the two mentioned above being Key West (Caudell).

Anisomorpha buprestoides (Stoll).

Miami, Fla., March 27, 28, 1910; 4 n.

Homestead, Fla., March 17–19, 1910; 1 ♀, 1 nearly adult and 2 quite immature specimens.

Long Key, Fla., March 13, 17, 1910; 5 n.

Key West, Fla., March 15, 16, 1910; 7 ♂, 3 ♀, 2 nearly adult and 2 quite immature specimens.

The youngest specimens in this series show that the longitudinal blackish lines of the adult are rarely present as pronounced continuous markings in the earlier stages of immaturity, in a few cases they are completely but weakly indicated and in most of the specimens are represented by more or less discontinued lineations on the head and thoracic segments. When the individuals are more than half the size of the adults, the lateral blackish lines are weakly indicated and the median one is proportionately narrower than in the adults and on the head, thorax, and portion of the abdomen divided by a hair-line of ochraceous. The adult specimens of both sexes are strongly patterned with black, the width of the median bar varying appreciably. The coloration of the adults is vandyke brown shading into russet, while that of the nymphs in the last stages of immaturity is wood-brown shading into bistre. It would be easy to mistake the nymphs in the last stage

of immaturity for specimens of a smaller, lighter, and more uniformly colored species of the genus.

The series here recorded was taken in a great variety of situations. Many were on the underside of coquina boulders, some between boards piled in a field and some under the bark of a dead pine log.

ACRIDIDÆ.

Apotettix rugosus (Sc.).

Miami, Fla., March 28, 1910; 6 ♂.
Homestead, Fla., March 17–19, 1910; 5 ♂, 2 ♀.
Key West, Fla., March 15, 1910; 1 ♂.

Considerable variation in the shape of the tegmina exists in this series, some individuals having the form distinctly oval, others have the ventro-distal margin more or less distinctly oblique-arcuate. These tettigids were taken at Miami and Homestead in small moist spots in the pine woods covered with very low swamp vegetation; at the latter place they were also taken in a marshy arm of the everglades. The specimen taken at Key West was beaten from *Ilex cassine* in a "powder-dry" field.

Neotettix variabilis Hancock.

Miami, Fla., March 28, 1910; 1 ♀.
Cocoanut Grove, Fla., 1887; 1 ♀ (TYPE) [U. S. N. M.].

This species is very close to *N. femoratus* (Sc.), agreeing in general form, character of dorsum of abdomen, and shape of the frontal costa; differing only in the smaller size, distinctly smaller tegmina, and regular dorsal carina of the caudal femora. More material may show this to be a geographic race of *N. femoratus*. The specimen from Miami was taken in a low spot in the pine woods near the south bank of the Miami River.

The type differs from the specimen from Miami in being more scabrous on the dorsum of the pronotum, much like specimens of *N. coarctatus*, but fully agreeing in the essentials, *i.e.*, the form of the facial forks and the short, apically rounded tegmina. The regularity of the dorsal carina of the caudal femora is not as marked in the type as in our specimen.

Neotettix coarctatus Hancock.

Apotettix minutus Rehn and Hebard, Proc. A. N. S. Phila., 1905, p. 34.

Miami, Fla., March 27, 28, 1910; 33 ♂, 33 ♀, 15 n: November 16, 1911 (Englehardt); 1 ♂, 1 ♀ [B. I.].
Cocoanut Grove, Fla., 1888; 1 ♀ (TYPE) [U. S. N. M.].

Dade County, Fla. (Hubbard and Schwarz); 1 ♀[13] (TYPE) [U. S. N. M.].

Homestead, Fla., March 17–19, 1910; 19 ♂, 23 ♀, 4 n.

Key West, Fla., March 15, 1910; 1 ♀ n.

Punta Gorda, Fla., November 12–14, 1911 (Davis); 2 ♂, 1 n. [U. S. N. M.].

Our specimens of this species agree perfectly with the types. This form is very close to *N. bolteri* Hancock, being probably a southern geographic race of the same, differing in the somewhat less robust form with the median carina of the pronotum less regularly arcuate and subdepressed between the humeral angles. The species occurs in one form with the pronotum elongate and another with the apex of the same not surpassing the tips of the caudal femora. The former of these is represented by ten males and five females from Homestead and four males and two females from Miami. In general appearance this form seems at first glance to be quite distinct from the form having the short pronotum, but careful comparison shows them to be identical. The present authors' *Apotettix minutus* is based on the elongate form, and in consequence their name falls into the synonymy, although it would have to be retained to distinguish this phase should a separate name be used to indicate it. The median carina of the pronotum is decidedly variable in strength in both of these forms. The general size varies considerably in both sexes and the coloration in a large number is quite uniform in tone without the usual paired blackish velvety spots. There is some variation in the rugosity of the pronotum, a few specimens having the rugæ very weak, but the subscutellate frontal costa readily separates these specimens from the *femoratus-variabilis* series.

This was the common species of tettigid on the wet ground, sparsely overgrown with the knee-high marsh grass, found on the arms of the everglades and in "pot-holes" in the pine woods.

Tettigidea spicata Morse.

Miami, Fla., March 28, 1910; 1 ♂ n.

This species, described from Georgia and Florida, has previously been definitely recorded from but one locality, San Pablo, in the latter State.

The specimen before us is probably in the next to last nymphal stage, and is referred without hesitation to this species. This nymph was taken in the low moist spots in the pine woods among very low swamp vegetation on the south bank of the Miami River.

[13] This specimen is the one recorded as "New Mexico" by Hancock. The accession number shows it to have been taken in Dade County, Florida.

Tettigidea lateralis (Say).

Miami, Fla., March 28, 1910; 4 n.
Homestead, Fla., March 17–19, 1910; 2 ♂, 3 ♀, 4 n.

Specimens of this genus were found in the same locations as the series of the two preceding genera but always in much smaller numbers. The nymphs all show the front margin of the pronotum distinctly angulate while the series of adults all have this margin broadly arcuate. This would suggest that the ancestral form from which this species is derived had the cephalic margin of the pronotum produced over the head in a distinct angle.

Radinotatum brevipenne peninsulare subsp. nov.

This insect differs from *Radinotatum brevipenne* in the longer head with much more produced rostrum and more concave face, longer antennæ, pronotum with shallower lateral lobes, more linear and usually shorter tegmina, longer and more slender caudal femora and more delicate, shorter, genicular angles. The subgenital plate in the male is also usually longer and more slender.

Type; ♂: Homestead, Dade County, Florida, about wire-grass in undergrowth of pine woods, March 17–19, 1910. (Hebard.) [Hebard Collection.]

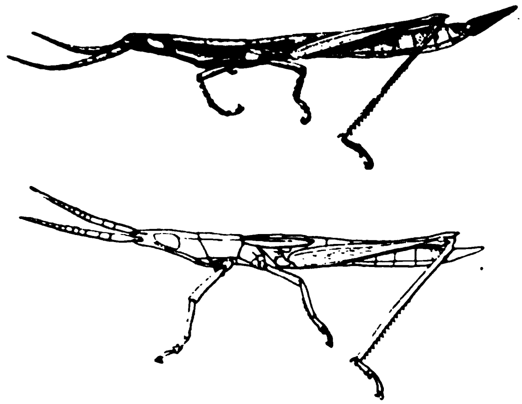
Size large for the genus. Body exceedingly slender and much compressed. Head nearly twice as long as pronotum, strongly produced, rostrate, face concave; fastigium in front of the eyes as long as the eyes, nearly twice as long as broad, the lateral margins parallel and strongly rotundato-rectangulate on the cephalic margin; antennæ long, triquetrous, rather broadly ensiform; eyes extremely elongate-ovate. Pronotum elongate, the dorsum subequal in width; lateral lobes vertical and subequal, cephalic margin very oblique, slightly concave, the ventro-cephalic angle sharp and obtuse, caudal margin broadly obtuse-angulate emarginate with the ventro-caudal angle sharp and acute. Tegmina as long as pronotum, decidedly elongate-lanceolate, narrowing proximad, apex very narrowly rounded, separated by a space nearly twice as great as the tegminal width. Subgenital plate very long and lanceolate, one and one-quarter times the length of the pronotum. Caudal femora exceedingly slender, nearly as long as the abdomen exclusive of the subgenital plate, with genicular angles produced, the inner considerably more so than the outer.

Allotypic ♀. Data the same as the type.

Considerably larger than the male, body less slender, antennæ proportionately more broadly ensiform, tegmina separated by a

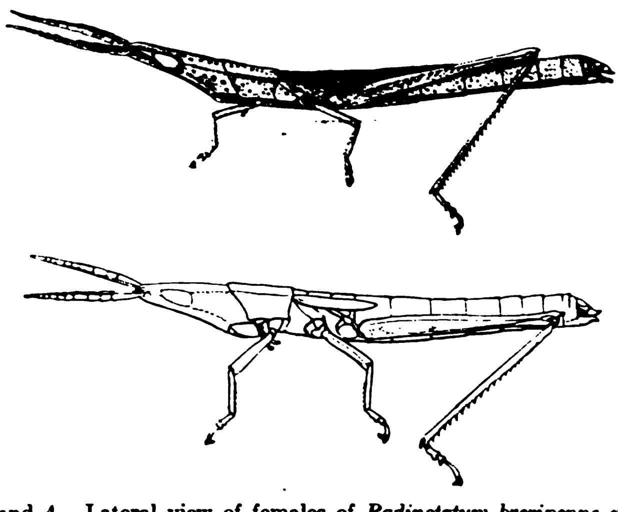
space somewhat more than twice the tegminal width, caudal femora much shorter than abdomen.

General color prout's brown, the lateral paired postocular lines very pale, the dorsal of these extending to the tips of the tegmina, the



Figs. 1 and 2.—Lateral views of males of *Radinotatum brevipenne peninsulare* (1, Type) and *R. brevipenne* (2; Thomasville, Ga.). (× 1½.)

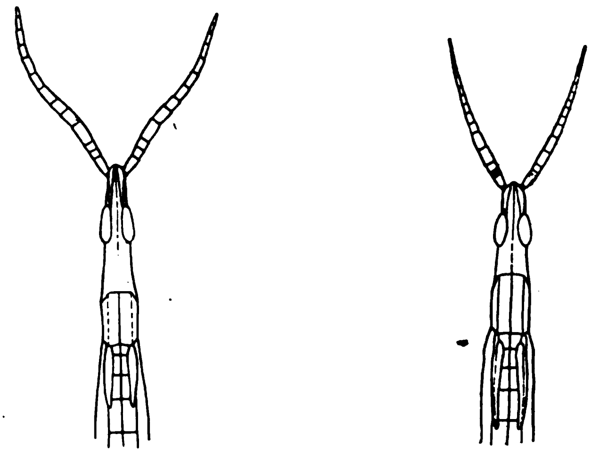
ventral extending to the ventro-caudal angle of the lateral lobes of the pronotum. These lines are particularly distinct in the male, and in the same sex there is also a medio-longitudinal bar of hair-brown on the dorsal surface of the head increasing in width ventrad. The



Figs. 3 and 4.—Lateral view of females of *Radinotatum brevipenne peninsulare* (3, Allotype) and *R. brevipenne* (4; Thomasville, Ga.). (× 1½.)

female is irregularly speckled about the head with clove-brown, but under the microscope this appears to be due to a diseased condition.

The type and allotypic female have been measured and the results are given below (in millimeters), together with the measurements of a male and female of *Radinotatum brevipenne* from Thomasville, Ga.; the latter specimens appear to be typical of that species over the greater part of its range.

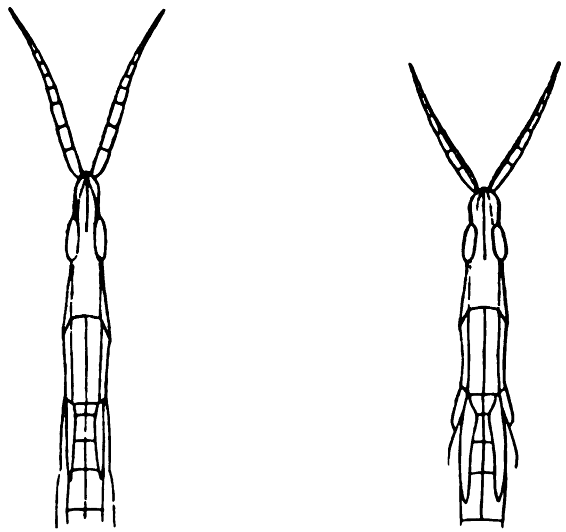


Figs. 5 and 6.—Dorsal outline of head and pronotum of males of *Radinotatum brevipenne peninsulare* (5, Type) and *R. brevipenne* (6; Thomasville, Ga.). (× 2.)

	R. brevipenne peninsulare.		*R. brevipenne.*	
	Type ♂.	Allotypic ♀.	Figured ♂.	Figured ♀.
Length of body	35.	44.	30.	40.
Facial length of head (to clypeal suture)	8.	10.	6.	8.
Length of fastigium (from eyes)	2.2	2.5	2.	2.2
Width of fastigium (in front of eyes)	1.2	1.7	1.5	2.
Length of antenna	13.5	14.	10.5	6.[14](11)
Length of pronotum	4.	5.5	4.	5.5
Width of pronotum	2.2	1.5	2.2	1.5
Depth of lateral lobe of pronotum	1.5	2.2	1.7	2.5
Length of tegmen	4.	6.	6.	7.
Greatest width of tegmen	.7	1.	1.2	1.5
Length of caudal femur	15.	18.	13.7	17.
Greatest width of caudal femur	1.2	1.5	1.7	2.
Length of subgenital plate	5.	....	3.	....

[14] Antennæ aborted, the length of the antennæ in other females from the same locality is given in parentheses.

In addition to the type and allotype, we have before us the following series which may be considered paratypic:



Figs. 7 and 8.—Dorsal outline of head and pronotum of females of *Radinotatum brevipenne peninsulare* (7, Allotype) and *R. brevipenne* (8; Thomasville, Ga.). (× 2.)

Figs. 9 and 10.—Dorsal view of distal extremity of caudal femur of females of *Radinotatum brevipenne peninsulare* (9, Allotype) and *R. brevipenne* (10; Thomasville, Ga.). (Greatly enlarged.)

Homestead, Fla., March 17–19, 1910; 35 ♂, 18 ♀, 1 ♀ n.

Miami, Fla., Jan. 27, 1899; 1 ♀: Jan. 29, 31 and Feb. 3, 1903; 2 ♂, 1 ♀: Feb. 6, 9, 1904; 9 ♂, 1 ♀, 1 ♀ n.: July 28, 1904; 1 ♀: March 20–28, 1910; 11 ♂, 6 ♀, 1 ♂ n., 1 ♀ n.: Nov. 16, 1911 (Englehardt); 2 ♂, 1 ♀, 1 n. [B. I.]: March 2 ♀ n. [U. S. N. M.].

Besides the paratypes we have before us a series of specimens from the following localities which belong to this species:

Fort Reed, Fla., April 28, 1876 (Comstock); 1 ♀ [Hebard Collection].

Gotha, Fla., October, 1901; 1 ♂, 2 ♀ [A. N. S. P.].

Tampa, Fla., January 17, 1904 (Hebard); 2 ♂, 1 ♀.

Chokoloskee, Fla.; 1 ♀ [Hebard Collection].

Capron, Fla.; 1 ♂ [U. S. N. M.].

In the large series from Homestead and Miami little variation is

to be found; both brown and green phases are represented, the former much more numerous, as has been observed in *Radinotatum brevipenne*. There is a suggestion of an approach toward *Radinotatum brevipenne* in one of the females from Gotha.

In the series of *Radinotatum brevipenne* before us we find an adult female from Daytona and a nymphal female from Archer, Fla., showing a strong approach to the southern form in several characters; in fact, these specimens are nearly intermediate between the two. A series from Gainesville and Ormond, Fla., show a tendency toward the southern form in a few characters. Examination of the types in the National Museum shows that *Radinotatum brevipenne* was described from individuals which have some of these characteristics, since these specimens were taken at Palatka, Fla., a locality but little north of the region where the two races intergrade.

The species here described was first recorded by Scudder[15] as *Achurum brevipenne* from Fort Reed, Fla. A large number of adults with a few nymphs were taken in this locality by Comstock between April 5 and May 1, 1876. Comstock[16] himself, speaking of these specimens, says that he has found the species north to the coast of Maryland. This latter record is highly improbable, as nymphs of the genus *Mermiria* were doubtless mistaken for the species. We feel able to make this assertion owing to the fact that considerable field work along the Atlantic coast has shown us that the range of *Radinotatum brevipenne* is limited to points far south of Maryland.

The present authors[17] have recorded this form as *Radinotatum brevipenne* on two previous occasions from Miami and Tampa, Fla., while Caudell[18] has similarly recorded it from Arcadia and Miami.

It is evident that this form has not been recognized previously owing to the fact that so little material of this genus has been available.

The range of *R. brevipenne peninsulare* covers the mainland of southern Florida and extends northward to the vicinity of the twenty-ninth degree of north latitude.

The species was common in the undergrowth of the pine woods.

Mermiria sp.

Miami, Fla., March 27, 28, 1910; 4 n.
Long Key, Fla., March 13, 1910; 1 n.

These specimens are quite immature.

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[15] *Proc. Bost. Soc. Nat. Hist.*, XIX, p. 88, 1877.
[16] *Introd. Ent.*, p. 101, 1888.
[17] *Trans. Am. Ent. Soc.*, Vol. XXVII, p. 331, 1902, and these *Proceedings*, p. 35, 1905.
[18] *Ent. News*, Vol. XVI, p. 217, 1905.

Macneillia obscura (Sc.).

Eritettix sylvestrus Blatchley, *A Nature Wooing*, pp. 192, 219, 1902.

Miami, Fla., March 28, 1910; 2 ♂, 4 n.
Homestead, Fla., March 19, 1910; 1 ♀.

There is great variation in this species, both in general coloration and in the intensity of the color pattern. In one of the males from Miami the general color is vandyke brown gradually changing dorsad to seal-brown on all but the upper edge of the wings, the dorsal median section of the pronotum between the supplementary carinæ and the corresponding portion of the head; these latter portions of the insect are clay color, naturally making a striking contrast. The other adult male from the same locality is nearly uniform prout's brown in color. This diversity of coloration is found throughout the series from other localities which we have studied.

We have received for examination one male and two females of this species from Ormond, Fla., taken April 10, 1899, by W. S. Blatchley. A male and female were correctly recorded as this species in *A Nature Wooing*, but the other female, which is highly colored and has the vertex slightly more produced, was described as *Eritettix sylvestrus* in that work. The species was described from two females, but the other type specimen has been destroyed. In the absence of a large series such an error is easily understood. We have before us females which agree perfectly with Blatchley's type, and in the frequent specimens which have the lateral carinæ strikingly whitish, the general superficial resemblance to *Eritettix* is very apparent. The more unicolorous specimens often have the lateral carinæ of the pronotum very faint and sometimes absent. The variability of this character in *Eritettix* has been noted by the present authors, and it is likely that such will be found to be true in still other species of the Truxalinæ.[19]

As is almost always found to be the case with this species, the six specimens from Miami were all found in an area not more than a rod in diameter. All of the specimens here recorded were taken in the undergrowth of the pine woods. The species may be considered scarce.

Amblytropidia occidentalis (Sauss.).

Miami, Fla., March 28, 1910; 5 ♂, 5 ♀.
Homestead, Fla., March 17–19, 1910; 1 ♂, 2 ♀.
Long Key, Fla., March 13, 1910; 3 ♂, 4 ♀.

[19] These *Proceedings*, 1910, p. 626.

Key Vaca, Fla., March 14, 1910; 7 ♂, 1 ♀.
Boot Key, Fla., March 14, 1910; 2 ♀.

We have before us all the available material of this species from southern Florida and find that specimens from Cape Florida on Key Biscayne, Long Key, Key Vaca and Boot Key, as a rule have the body slightly more compressed, the face more retreating, and the caudal femora slightly more slender. These differences from mainland individuals are, however, very slight, not absolutely constant and sometimes but one of the three may be appreciable, while a few mainland specimens possess the usual insular characters.

In size the Miami and Homestead individuals are but slightly larger than Thomasville, Ga., specimens. The Boot Key and Key Vaca representatives are much the same size as those from Miami and Homestead, although several males are distinctly larger than Thomasville individuals of the same sex. The Long Key specimens exceed in size any individuals of the species seen by us, the females particularly being very large. A series of five males and six females from Cape Florida on Key Biscayne, average larger than any series except that from Long Key. Measurements (in millimeters) of average individuals from the localities mentioned above are as follows:

MALES.

	Thomasville.	Miami.	Homestead.	Cape Florida.	Long Key.	Key Vaca.	Boot Key.
Length of body	18.8	20.2	21.9	22.8	24.2	23.	22.
Length of pronotum	4.	4.2	4.5	4.6	5.	4.6	4.3
Length of tegmen	16.8	16.2	18.	19.	19.3	18.	18.
Length of caudal femur	13.	13.5	14.5	15.5	16.2	15.	15.

FEMALES.

	Thomasville.	Miami.	Homestead.	Cape Florida.	Long Key.	Key Vaca.
Length of body	24.5	29.	29.5	31.	31.8	29.5
Length of pronotum	5.1	5.5	5.9	5.8	7.	6.
Length of tegmen	20.5	21.	20.8	23.2	25.	22.2
Length of caudal femur	16.5	18.5	17.5	20.2	21.8	19.2

The usual polychromatism of the species is exemplified in the present series. The Long Key females are all of the strongly bicolored type with the dorsal aspect uniform ochraceous and the lateral and ventral faces nearly uniform seal-brown. The males from the same locality are similarly but much less decidedly colored, the same also being true in the case of the Key Vaca individuals.

The specimens taken on the Florida mainland were all captured in the undergrowth of pine woods. Pines do not grow on any of the Keys which were examined, and the specimens of this species were there found in the luxuriant tangles on the edge of the scrub and in a sort of wire-grass.

Orphulella pelidna (Burm.).

Miami, Fla., March 20, 27, 28, 1910; 5 ♂, 4 ♀, 2 n.: November 16, 1911 (Englehardt); 1 ♀ [B. I.].
Homestead, Fla., March 17–19, 1910; 1 ♀.
Long Key, Fla., March 13, 1910; 2 ♂, 3 ♀.
Key Vaca, Fla., March 14, 1910; 3 ♂, 3 ♀, 1 n.
Boot Key, Fla., March 14, 1910; 3 ♂, 3 ♀, 1 n.
Key West, Fla., March 15, 16, 1910; 2 ♂, 5 ♀: November 21, 1911 (Englehardt); 2 ♀ [B. I.].

These specimens are similar in character to New Jersey individuals of the species, exhibiting considerable diversity in size and relative tegminal length, even in specimens from the same locality. Practically all of the color phases found in the species are represented in the south Florida series.

At Miami and Homestead this species was found in wet depressions in the pine woods, while on Long Key and Key Vaca it was taken among the salt-marsh grasses growing scantily on the otherwise bare coquina rock of the low wet portions of these Keys. At Boot Key the specimens were taken among scant tufts of wire-grass growing on the coquina, and were noticed to resemble very closely in color the surface of the rock. The species was found quite plentiful at Key West among the peculiar halophytic plants which grow on the bare coquina.

Arphia granulata Sauss.

Miami, Fla., March 27, 28, 1910; 9 ♂, 2 ♀, 2 n.
Homestead, Fla., March 17–19, 1910; 4 ♂.
Key West, Fla., March 15, 16, 1910; 12 ♂, 6 ♀.

Several males and females from Key West vary from burnt umber to chestnut in general coloration and are very little mottled, the rest of the specimens of the series here recorded have as a basic color clove-brown, usually variously mottled with a lighter color. In these latter specimens the two dark bands on the caudal femora are generally quite pronounced, while in the more reddish individuals these bands are either very faint or wholly lacking.

This species was found in open spots in the pine woods at Miami and Homestead, at the former place not infrequently. At Key

West the species was quite plentiful in the open spots in the scrub, where on the previous visit it was only occasionally found.

Chortophaga australior R. and H.

Palm Beach, Fla., November 12, 1911 (Englehardt); 1 ♂ [B. I.].

Lemon City, Fla.; (E. J. Brown); 2 ♂. [U. S. N. M.]

Miami, Fla., March 27, 28, 1910; 8 ♂, 4 ♀, 3 n: March (Dyar and Caudell); 1 ♀ [U. S. N. M.].

Homestead, Fla., March 17, 18, 1910; 2 ♀.

Key Vaca, Fla., March 14, 1910; 4 ♂, 2 ♀.

Key West, Fla., March 15, 16, 1910; 18 ♂, 11 ♀: November 21, 1911 (Englehardt); 2 ♂, 4 ♀ [B. I.]: March (Dyar and Caudell); 7 ♂ [U. S. N. M.]: April 13, 1903 (Schwarz); 1 ♀ [U. S. N. M.].

In the present series there are but seven specimens in the green color phase, all of which are females and, with the exception of one individual from Miami, were taken at Key West. One of the female specimens from Key Vaca and one from Key West show a decided approach to this color form, but in these specimens the face and dorsal surface of head and pronotum are suffused with ferruginous, while the bases and tips of the caudal femora are washed with madder-red, which color is more faintly indicated on the contiguous portions of the tegmina. In a large number of the darker specimens before us, the light cruciform marking on the pronotum is very noticeable.

This decidedly campestrian species was abundant wherever found. The insects fly up with alacrity when disturbed, making a whirring, clicking sound in their flight. Although this species is always found in large colonies, the insects are sufficiently wary and rapid in flight to cause the capture of a series to be quite a task.

Scirtetica marmorata picta (Sc.).

Capron, Fla., April 24; 1 ♀ [U. S. N. M.].

Palm Beach, Fla., November 12, 1911 (Englehardt); 1 ♂ [B. I.].

Miami, Fla., March 27, 28, 1910; 13 ♂, 3 ♀, 1 n: November 16, 1911 (Englehardt); 1 ♀ [B. I.].

After examining about one hundred specimens of *Scirtetica marmorata* from Massachusetts, Connecticut and New Jersey and eighty-one specimens which are referable to *picta*, we have reached the conclusion that Morse's suggestion[20] that the two forms are but geographic races of the same species is strongly supported by our material. Unfortunately, we lack specimens from eastern Virginia and northeastern North Carolina, but we now have a sufficient

[20] Publ. 18, Carnegie Inst., p. 37, 1904.

series from southwestern North Carolina to prove to us that intergraduation does exist.

The characters of typical individuals of the two races can best be shown in tabular form:

S. marmorata.	*S. marmorata picta.*
Wing narrower, its greatest width contained one and three-fourths to one and seven-eighths times in the length.	Wing broader, its greatest width contained one and one-half to one and three-fourths times in the length.
Disk of wing sulphur-yellow.	Disk of wing varying from deep chrome to cadmium-yellow.
Wing band relatively narrow, always narrower than the width of the colored disk, never continued around to the internal margin of the wing.	Wing band relatively broad, rarely narrower than, usually as broad as the width of the colored disk, continued around to, or nearly to, the internal margin of the wing.
Disk of pronotum frequently with pale decussate markings.	Disk of pronotum never with pale decussate markings, uniform in color.

In addition to these features certain others are evident in a number of specimens, but not so consistently as to be considered diagnostic. These are the usually more distinct median carina of the pronotum of *marmorata*, the very frequent breaking up in *picta* of the three

Figs. 11 and 12.—Tegmen and wing of male of *Scirtetica marmorata* (11, Clementon, N. J.) and of same sex of *S. marmorata picta* (12, Miami, Fla.). (× 1½.)

usually present and well-defined dark tegminal cross bars of *marmorata*[21] and the usually more robust build of *marmorata*. The pronotum of *marmorata* is more constricted cephalo-mesad than is

[21] In the unicolorous individuals which occur in both races these maculations are almost absent.

that of *picta*, but as this can hardly be appreciated without actual comparison of specimens, we have not given it in the above table.

Specimens from Winter Park, New Hanover County, North Carolina, have the proportions of the wings intermediate between the extremes of *marmorata* and *picta*, while the bands of the wings are no wider than in *marmorata* and of similar form, although the color of the disk is closer to *picta* in several specimens and exactly intermediate in others. Several of these specimens also have traces of the decussate pronotal markings of *marmorata*, while the character of the median carina of the pronotum and of the pronotal constriction is closer to *picta*. From these notes it can easily be seen that the characters of the two forms are blended in the individuals from southeastern North Carolina. In consequence of this we have used a trinomial for this form.

The specimens from Miami were taken in the pine woods.

Psinidia fenestralis (Serv.).

Palm Beach, Fla., November 12, 1910 (Englehardt); 1 ♂, 1 ♀ [B. I.].

Miami, Fla., March 28, 1910; 5 ♂, 4 ♀, 1 n.

The coloration of the disk of the wings in this series ranges from orange-buff to orange. The species was found fairly abundant in sandy spots in the pine woods.

Romalea microptera (Beauv.).

Miami, Fla., March 28, 1910; 1 n.

Homestead, Fla., March 17, 18, 1910; 4 n.

Four of these specimens are in the same nymphal stage and would all approximate a length of 12 mm. if not shrunken. The remaining specimen, from Homestead, is apparently in the following nymphal stage and is 19 mm. in length.

The coloration of nymphs of this species is constant, all are black marked with yellowish-red, as is fairly well shown by Glover[22] in his illustration of the nymph of this species. These markings, contrary to that illustration, border only the caudal margin of the pronotum, and in the specimens in the more immature stage before us are orange-vermilion. The specimen in the nymphal stage following has these markings colored saturn red. We have noticed that the newly emerged nymphs of this species have these markings nearly vermilion, while in the nymphs approaching maturity the same markings are usually cadmium-yellow.

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[22] *Ill. N. A. Ent., Orth.*, pl. 3, fig. 4, 1872.

All of these specimens were taken in the grasses of the everglades. At this time of year colonies of these, each usually numbering several dozen, may be found in such places, all close to the spot from which they have emerged from the ground.

Leptysma marginicollis (Serv.).

Miami, Fla., March 28, 1910; 1 ♂, 3 ♀.
Homestead, Fla., March 17–19, 1910; 3 ♂, 3 ♀, 1 n.

One female specimen from each of these localities has the general coloration oil green instead of the prout's brown coloration usually found in this species: the dorsal surface, however, in each of these specimens is cinnamon. The lateral pale bars are strongly indicated in all but one of the adults here recorded. The series before us would indicate that in this species there is some increase in size southward, but we find that this is not constant. The length of the females which we have examined from southern Florida varies from 32.5 mm. to 38.5 mm.

At Homestead the specimens were all taken among grasses in the everglades, while those from Miami were captured among a few cat-tails growing in a wet spot.

Schistocerca americana Sc.

Miami, Fla., March 20, 27, 1910; 3 ♂, 1 ♀.
Key Largo, Fla., March 18, 1910; 1 ♂.
Long Key, Fla., March 13, 1910; 2 ♂, 2 ♀.
Key Vaca, Fla., March 14, 1910; 1 ♂, 1 ♀.
Boot Key, Fla., March 14, 1910; 1 ♂, 1 ♀.
Key West, Fla., March 15, 16, 1910; 4 ♂, 1 ♀: November 21, 1911 (Englehardt); 1 ♀ [B. I.].

In this series of specimens, taken in extreme southern Florida, the wing length in many cases, notably in the individuals from the Keys, is much less than the average of those from more northern localities. The following measurements in millimeters give the average of some forty specimens we have examined; the figures in parentheses indicate the range of variation in specimens from the region given.

	Length of pronotum.	Length of tegmina.
Males from southern Florida	8.2 (7.5 to 8.7)	37.4 (34.5 to 40.5)
Males from Georgia to Pennsylvania	8.3 (8.2 to 9.)	43.8 (41.7 to 47.2)
Females from southern Florida	10.4 (9.5 to 12.)	46.9 (42.2 to 50.)
Females from Georgia to Pennsylvania	10.6 (10. to 10.7)	56.8 (54. to 58.5)

In other respects the southern Florida specimens are inseparable from those taken farther north, and can certainly not be considered worthy of racial distinction.

The specimens from Long Key and Key West are paler than is usual in southeastern individuals of this species, but show no approach whatever to the Cuban *Schistocerca pallens*.

At Miami this species was not uncommon in the pine woods; it was occasional on the Keys and was noticed to be plentiful on Long Key among beach vegetation on the shore.

Schistocerca damnifica calidior subsp. nov.

This southern or Lower Austral representative of *Schistocerca damnifica* of the Upper Austral Zone is separated from the typical form by the greater general size, the more elongate and proportionately much slenderer tegmina, longer and more filiform antennæ and slenderer caudal femora. The insect is, in the new form, much more elongate than in *damnifica* sensu strictiore, and the general appearance is quite different, but in analyzing the characters we find it hard to express the differences except in a few features.

The median carina of the pronotum is, in the new form, very generally less elevated and arcuate, and more depressed when seen from the side, but this is not absolute as quite a few specimens of *S. damnifica calidior* have this carina appreciably arcuate. The width of the marginal and discoidal fields of the tegmina, taken at the distal third, is in the male of true *damnifica* (ex New Jersey) contained four and one-half to four and three-quarters times in the greatest tegminal length, in the female of the same form this proportion varies from the same as in the male to having the tegminal width contained five times in the tegminal length. The male of the new form has the same width of the tegmina contained from six to nearly seven times in the tegminal length, while the female has the width contained from five and one-half to six and one-quarter times in the length.

The caudal femora of *damnifica* s. s. have the greatest width contained from four to four and one-quarter times in the length of the same, while *S. damnifica calidior* has the width of the same contained four and one-half times in the length.

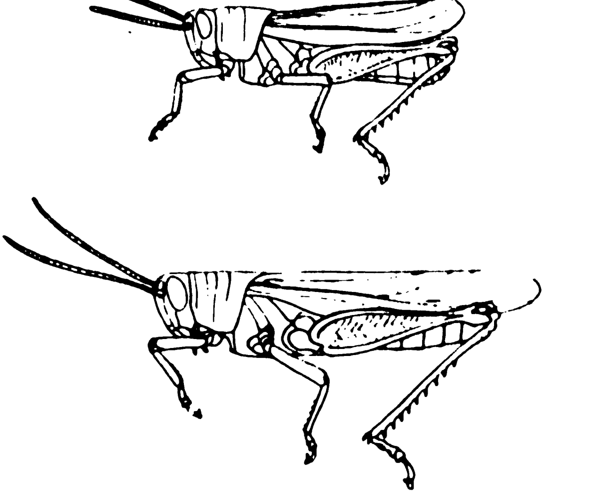
The original description of *damnifica* is clearly based on the northern form, the measurement of length (37 mm.) perfectly fitting northern female specimens, while this measurement is much surpassed in that sex of the southern form. The type locality—Tennessee—is near the range of the southern race, and specimens from that region do

not represent the extreme condition of the northern form as found in New Jersey; however, we have Asheville, N. C., specimens which would doubtless agree with Saussure's original material, and these are decidedly the northern form.

We find that none of the synonyms of *damnifica* were based on the southern race, and in consequence a new name is necessary to designate this distinctly differentiated form. Scudder used the previously unpublished *Acridium appendiculatum* Uhler MSS. for specimens of the form here described, but as it was unaccompanied by a description that name must date from Provancher, who referred a specimen said to be from Canada to it. Scudder examined this individual and assigned it to *damnifica*.

Type: ♂; Homestead, Dade County, Fla., undergrowth in pine woods, March 17–19, 1910. (Hebard.) [Hebard Collection.]

Size medium (for the genus). Form subcompressed, slender; surface of greater portion of the body impressed ruguloso-punctate.



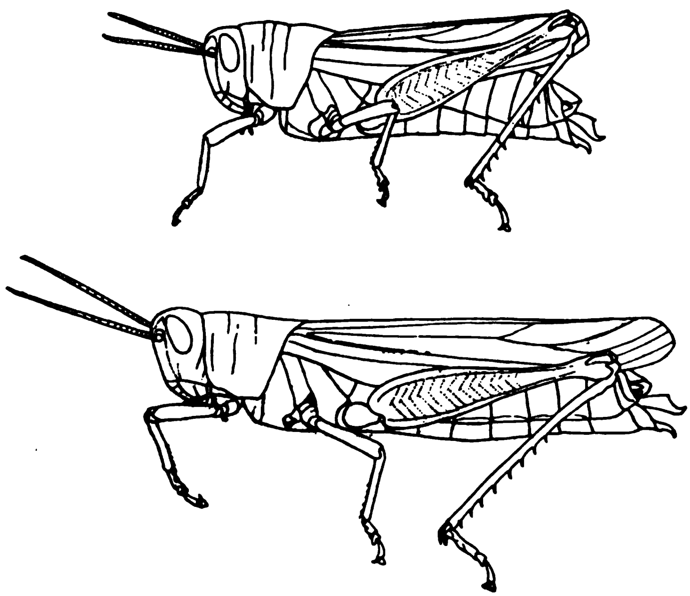
Figs. 13 and 14.—Lateral outlines of males of *Schistocerca damnifica* (13; Stafford's Forge, N. J.) and *S. damnifica calidior* (14; Type). (× 1½.)

Head with the frontal costa subequal in width, not expanded between the antennal bases, non-sulcate; eyes ovate, less elongate than in true *damnifica*; antennæ very slightly shorter than twice the greatest dorsal length of the pronotum, subfiliform. Pronotum with the median carina not at all elevato-arcuate, nearly straight when seen from the side; caudal angle of the disk subrectangulate. Tegmina

moderately elongate, surpassing the tips of the caudal femora by two-thirds of the dorsal pronotal length, the width of the distal third contained about six and one-half times in the greatest length of the same; apical portion moderately narrowed by the arcuation of the costal margin, the immediate apex obliquely rotundato-truncate. Caudal femora moderately robust but with the distal third slender, the greatest width contained four and one-half times in the length of the same.

Allotypic female. Miami, Dade County, Fla., undergrowth in pine woods, March 27, 1910. (Hebard.) [Hebard Collection.]

Agrees with male except in the following characters. Size considerably greater than in male. Antennæ nearly one and one-half times the dorsal length of the pronotum. Caudal angle of the pronotal disk rounded obtuse-angulate. Tegmina in form similar



Figs. 15 and 16.—Lateral outlines of females of *Schistocerca damnifica* (15; Stafford's Forge, N. J.) and *S. damnifica calidior* (16; allotype). (× 1¼.)

to those of the male, surpassing the tips of the caudal femora by one-half of the dorsal pronotal length, the width at the distal third contained slightly more than six times in the length. Caudal femora with the greatest width contained four and two-third times in the length of the same.

General color walnut-brown, passing ventrad into russet and tawny-olive, the narrow but moderately defined median line on the head and pronotum russet, while the anal area of the tegmina is wood-brown, margined laterad by the burnt-umber wash of the remainder of the tegmina. Antennæ passing from cinnamon-rufous at the base to hazel at the tips; eyes russet.

Measurements (in millimeters).

	S. damnifica.[23]		*S. damnifica calidior*.	
	♂.	♀.	♂ Type.	♀ Allotype.
Length of body	23.8	34.	29.	46.5
Length of pronotum	6.	8.5	7.2	9.5
Length of tegmen	17.5	23.2	25.8	34.
Length of caudal femur	13.2	18.	21.5	22.2

In addition to the type and allotypic female we have before us the following specimens which may be considered paratypic:

Miami, Fla., March 27, 28, 1910; 7 ♂, 2 ♀: November 16, 1911 (Englehardt); 2 ♀ [B. I.].

Homestead, Fla., March 17–19, 1910; 7 ♂.

The male individuals are fairly uniform in coloration, some few specimens having the general tone deeper and more umber, while others have the discoidal field of the tegmina distinctly crypto-maculate. The additional Miami females, however, have the general colors more clay color and bistre, with the pronotum strongly marked with the latter and the discoidal and marginal fields of the tegmina strongly maculate with the same, the caudal tibiæ also being quite purplish. These specimens greatly resemble brownish individuals of *S. alutacea*.

In studying this form we have had before us a series of over one hundred and forty specimens of the two forms from south of Virginia, a sufficient series to enable us to map with considerable accuracy the limits of the range of both forms.

True *damnifica* probably ranges over the entire Upper Austral Zone, extending southward over the Appalachian system as far as Gainesville and Atlanta, Ga., and eastward over the lower country to Raleigh, N. C. The specimens from Raleigh and Atlanta show a slight approach to *S. damnifica calidior*, but in general form they are much closer to the northern type. The new form is typical north-

[23] The specimens whose measurements are here given are from Stafford's Forge, N. J., and have been used for comparison with the new form as well as having been figured above.

ward as far as Yemassee, S. C., and Thomasville, Ga. Specimens from the region about Florence, S. C., Wilmington and Fayetteville, N. C., show decided tendencies toward the northern form, although they are in general more representative of *calidior*. The area of intergradation is between the Blue Ridge and the low coastal plain region, probably being approximately marked by the fall line.

S. damnifica calidior was occasional in the low undergrowth of the pine woods at Homestead and Miami, at the latter locality it was plentiful at one place where the undergrowth was more than waist high on the edge of a hammock. The males are active and fly with quite the vigor of *S. alutacea*.

Arranging our material from the Southeastern States according to the above distribution, we have the localities grouped as follows:

Schistocerca damnifica (Sauss.).

North Carolina; Asheville,[24] Raleigh.[24]
Georgia; Gainesville, Atlanta.[25]

Schistocerca damnifica calidior subsp. nov.

North Carolina; Fayetteville, Wilmington, Winter Park.
South Carolina; Florence, Yemassee.
Georgia; Tybee Island, Isle of Hope, Sandfly, St. Simon's Island, Cumberland Island, Brunswick,[25] Waynesville,[25] Jesup, Okeefenokee Swamp, Albany,[25] Thomasville.[26]
Florida; Live Oak, Jacksonville, San Pablo,[27] Pablo Beach,[27] Gainesville,[27] Melbourne, Miami, Homestead, Chokoloskee.[28]

Melanoplus puer Sc.

Miami, Fla., March 20–28, 1910; 19 ♂, 8 ♀, 2 n: November 16, 1911 (Englehardt); 2 ♂, 1 ♀ [B. I.].
Homestead, Fla., March 17–19, 1910; 14 ♂, 8 ♀, 3 n.

The series before us shows a marked increase in size over the specimens of the type series from Fort Reed, Fla.[29] The males range in length from 13.5 to 17 mm., while the females are from 19 to 22.5 mm.; the majority of the adults measuring nearest the maximum. The insects here recorded are also all proportionately heavier than the types, with strongly developed caudal femora. We find, therefore, that the species materially increases in size in its southward range and that it cannot be ranked among the

[24] These *Proceedings*, p. 632, 1910.
[25] *Ibid.*, 1910, p. 594.
[26] *Ibid.*, 1904, p. 789.
[27] *Ibid.*, 1907, p. 292.
[28] *Ibid.*, 1905, p. 40.
[29] *Proc. Bost. Soc. Nat. Hist.*, Vol. XIX, p. 87, 1877.

smaller species of the genus. The caudal margin of the disk of the pronotum is very broadly V-shaped emarginate mesad, both in the specimens here recorded and in the type series. The males show a considerable amount of variation both in length and shape of the cerci. The majority, however, agree with Scudder's description, but one specimen has the cerci acutely styliform beyond the thickened base and a number of individuals show a tendency to have the tip subspatulate. The figures given by Scudder[30] of the extremity of the male abdomen of this species are extremely poor.

Figs. 17 and 18.—Lateral and dorsal views of the apex of abdomen of male *Melanoplus puer* from Miami, Fla. (× 6.)

Scudder's color description is based on dried alcoholic specimens, as the typical series are all in that condition, and we have consequently deemed it advisable to give the following color notes.

In the series before us the general color in the males varies from russet to drab tinged with raw umber and in the females from burnt umber to clove-brown tinged with vandyke brown. In the males the customary spot on the lateral lobes of the pronotum is very pronounced, piceous, triagonal in shape and covers about half the lateral surface of the lobes; the females are not so noticeable in this respect since they are, as a rule, darker in general coloration and have this spot smaller and less intense. In all of the males the sides of the first four abdominal segments are piceous, which color consequently extends considerably beyond the tips of the tegmina; this marking is, in the females, suggested in only a few specimens. The hind femora in both sexes are usually heavily twice banded, with the apex also blackish, the darkest specimens alone having these bands faintly indicated. The ventral face of the caudal femora is gamboge-yellow, sometimes changing caudad to deep chrome in the males, and saturn red usually shading to flame scarlet on the outer edge in the females. In both sexes the caudal tibiæ are without exception deep heliotrope-purple.

The species is local in distribution and is usually found in small colonies in the undergrowth of the pine woods; it was scarce at

[30] *Proc. U. S. N. M.*, Vol. XX, pl. XVII, fig. 2, 1897.

Homestead, but locally common at Miami. The saltatorial ability of this insect is surprising, but it is easily taken owing to the fact that its movements are seldom hasty.

Paroxya atlantica Sc.

Miami, Fla., March 20–28, 1910; 16 ♂,[31] 8 ♀, 1 n (nymphs were exceedingly abundant): November 16, 1911 (Englehardt); 2 ♀ [B. I.].

Homestead, Fla., March 17–19, 1910; 4 ♂, 6 ♀, 1 n (nymphs were exceedingly abundant).

We have examined the entire series previously recorded from southern Florida by us as well as the material now being studied and find that, when compared with specimens of the type series from Georgia,[32] the individuals from Miami, Cape Florida on Key Biscayne and Homestead are considerably smaller, more attenuate, with proportionately longer tegmina and wings and usually lighter coloration. There are no characters to be found in the series, however, which would warrant its being considered a racial form. The specimens before us from Thomasville, Ga., agree in every respect with typical specimens.

Measurements (in millimeters).

	Typical ♂[33] Sandford, Fla.	♀ Cotype, Georgia.	Average in present series. ♂	♀
Length of body	22.5	29.	18.	24.
Length of tegmen	17.	18.	15.	17.5
Width of tegmen	3.2	4.	2.6	3.5
Length of hind femur	13.	16.	11.5	13.5
Width of hind femur	3.	4.	2.8	3.2

The specimens here examined were all taken in damp spots in the pine woods.

Paroxya atlantica paroxyoides (Sc.).

Melanoplus paroxyoides of authors.

Key Largo, Fla., March 18, 1910; 4 ♂, 4 ♀, 3 n.[34]
Long Key, Fla., March 13, 1910; 9 ♂, 5 ♀, 1 n.[34]
Key Vaca, Fla., March 14, 1910; 10 ♂, 9 ♀.

[31] These specimens show conclusively that the species first reaches maturity at Miami in late March. All of these specimens have recently reached the adult condition, and seven have the curved white line peculiar to the nymphal state still indicated on the sides of the pronotum.

[32] These specimens were sent to Professor Bruner by Mr. Scudder and are now in the Hebard Collection ex Bruner.

[33] *Proc. U. S. N. M.*, Vol. XX, p. 382, 1897.

[34] These specimens in nymphal stages have the bands of the caudal femora already well marked.

Boot Key, Fla., March 14, 1910; 1 ♀.

Key West, Fla., January 19, 1904;[35] 17 ♂, 9 ♀: March 15–16, 1910; 9 ♂, 7 ♀: November 21, 1911 (Englehardt); 1 ♀ [B. I.].

The species *Melanoplus paroxyoides*[36] was described by Scudder from three males and four females taken at Key West and Tallahassee, Fla., and a male single type from Key West has been selected by the present authors.[37] It is hard to understand how this species could have been placed in the genus *Melanoplus* by a worker familiar with the genus *Paroxya*. The types[38] show that it is but a geographic race of *Paroxya atlantica*, so near typical specimens of the latter now before us that we must rely almost wholly on coloration to separate the two forms.

The series at hand from the southern Keys differs, it is true, from true *atlantica* in being, as a rule, smaller but somewhat heavier, with proportionately shorter tegmina and more robust caudal femora; moreover, the male cerci are usually longer, more attenuate and roundly spatulate at the apex, while the supra-anal plate is more subtriangulate in outline.

On the other hand, careful examination of the entire series of eighty-eight specimens from the southern Keys shows that none of these characters are sufficiently constant to be of diagnostic value and that no constant structural differences exist.

The coloration of the caudal tibiæ is, however, in the majority of the specimens from the southern Keys, quite distinctive and a grayish suffusion is frequently noticeable. A large number of individuals have the lateral face of the caudal femora heavily trifasciate with very dark brown, quite a few specimens have these markings very pale, while in others the entire surface is darkly suffused; in every specimen examined, however, the inner half of the dorsal face of the caudal femora is noticeably thrice spotted with the color which, in the more heavily marked individuals,

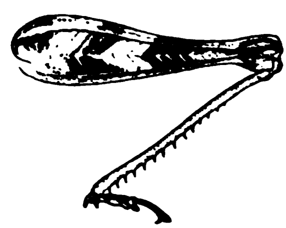


Fig. 19.—Caudal limb of male *Paroxya atlantica paroxyoides*, from Key Vaca, Fla. (× 3.)

[35] These twenty-six specimens from Key West were recorded as *P. atlantica* by the present authors; these *Proceedings*, 1907, p. 298.

[36] *Proc. U. S. N. M.*, Vol. XX, p. 331, 1897.

[37] These *Proceedings*, 1912, p. 86.

[38] Type and two paratypic females from Key West, Fla. (Morrison), in Hebard Collection ex Bruner.

characterizes the tri-fasciate markings; these spots if present at all, are almost never so pronounced in true *atlantica.*

The series from the southern Keys are readily separable from specimens of *atlantica* from the mainland and Cape Florida on Key Biscayne, although their characters are practically intangible and exceedingly difficult to express without exaggeration.

Caudell's record of *Melanoplus paroxyoides* from Miami[39] belongs to *Paroxya atlantica;* the paratypes from Tallahassee, Fla., should doubtless be referred to the same form.

This geographic race is usually found fairly abundant in the low halophytic vegetation growing on the otherwise almost bare coquina rock of the Keys and also in the tangled growth along the edge of the scrub.

Average measurements (in millimeters).

	♂	♀
Length of body	20.	27.
Length of tegmina	14.8	17.
Width of tegmina	3.	3.9
Length of hind femora	12.	14.7
Width of hind femora	3.	3.9

Aptenopedes clara Rehn.

Punta Gorda, Fla., November 11, 1911 (Davis); 1 ♀ [U. S. N. M.].
Palm Beach, Fla., January 24 (Dyar); 1 ♀: 1 ♀ [U. S. N. M.].
Miami, Fla., March 27, 28, 1910; 3 ♂, 5 ♀, 3 n: November 16, 1911 (Englehardt); 1 ♀ [B. I.].
Homestead, Fla., March 17–19, 1910; 5 ♂, 3 ♀.
Long Key, Fla., March 13, 1910; 2 ♂, 1 n.
Key Vaca, Fla., March 14, 1910; 4 ♂.
Boot Key, Fla., March 14, 1910; 3 ♂, 1 ♀.
Key West, Fla., March 15, 16, 1910; 4 ♂, 2 ♀: November 16, 1911 (Englehardt); 1 ♀ [B. I.].

This series shows that while there is considerable variation in size, both geographic and individual, in the present species, the characters originally given hold true in the series of seventy specimens now available for study. As previously pointed out by us,[40] male specimens from Tampa are not quite typical in the form of the cerci, these being less elongate and not as decidedly falcate as in individuals from southern Florida, but in all other characters they are fully representative of *clara.* It is possible that this species is a geographic race of *sphenarioides,* but we have no positive evidence of this or even of approach to that form except in the shortening of the distal portion of the cerci in the Tampa specimens.

[39] *Ent. News,* Vol. XVI, p. 218, 1905.
[40] These *Proceedings,* 1905, p. 41.

The males of the two species may be separated by the following characters:

A. sphenarioides.	*A. clara.*
Antennæ shorter.	Antennæ longer.
Furcula narrow, digitiform, tips variable in production.	Furcula broad depressed lobes, hardly produced.
Supra-anal plate narrow, lateral margins in large part straight and subparallel.	Supra-anal plate broad, lateral margins arcuate, not subparallel.
Cerci short, simple, styliform.	Cerci elongate, acute falcate distad.

The form of the cerci of the males varies somewhat in the present series, although in all cases the general outline remains the same. The variation lies entirely in the width of the cercus, the degree of falcation of the distal portion and the presence or absence of a very broad, blunt angulation at the distal third of the dorsal margin. The Cape Florida specimens previously recorded and measured by us,[41] in the male sex surpass in size any individuals of that sex in the present series, although in the female they are equalled by Miami, Homestead, Boot Key, and Key West representatives.

The range of this beautiful species is now known to extend north to Tampa, south on the mainland at least as far as Homestead and over the Keys to Key West. We have no knowledge of the limit of its range along the east coast of Florida. Scudder's records of *Aptenopedes sphenarioides* from Key West and Biscayne Bay[42] are erroneous references of female individuals of this form[43] to the more northern species.

On the Keys this species was found in very scant numbers, usually on the edge of the scrub where the low undergrowth was unusually heavy, while on the mainland the specimens were taken in low spots in the pine woods and once or twice were beaten from the marsh grasses growing on arms of the everglades.

Aptenopedes aptera Sc.

Miami, Fla., March 20–28, 1910; 2 ♂, 2 ♀.
Homestead, Fla., March 17–19, 1910; 1 ♂.

[41] *Ibid.*, p. 41.
[42] *Proc. U. S. N. M.*, Vol. XX, p. 400, 1897.
[43] We have before us, ex Cln. Bruner, a Biscayne Bay female examined by Scudder and labelled *sphenarioides* by him when studying the genus for his Melanopli revision. This specimen is of course *clara*. Doubtless he would have separated the species if he had had the more easily recognized male.

The specimens here recorded were captured in the low undergrowth of the pine woods, all of the individuals seen being taken.

TETTIGONIIDÆ.

Stilpnochlora marginella (Serv.).

Lake Worth, Fla., June 24, 1889; eggs [U. S. N. M.].

Key West, Fla., March 16, 1910; 1 ♀: April 24, 1881 (Schwarz); 1 adult [U. S. N. M.].

The collection of the Academy contains a male specimen labelled "Fla." This individual has been compared with material from Cuba, Mexico, Nicaragua, Costa Rica, and Cayenne. The only previous records of this species from within the United States were those from the Tortugas by Scudder[44] from Chokoloskee, Fla., by the authors[45] and from Florida by Caudell.[46]

The specimen taken by the junior author was beaten from a high bush, *Ilex cassine*, some ten feet from the ground, and when opened for stuffing was found to contain one hundred and twenty-four fully developed and fourteen partially developed eggs. The specimen is somewhat battered, and it is probable that very few specimens of the species survive the winter in this region.

Scudderia texensis Sauss. and Pictet.

Miami, Fla., March 28, 1910; 2 ♂: November 16, 1911 (Englehardt); 1 ♀ [B. I.].

The collection of the Academy contains a male taken at the same locality on January 20, 1899, by S. N. and M. C. Rhoads.

Microcentrum rhombifolium (Sauss.).

Miami, Fla., March 27, 1910; 1 ♂.

This specimen was taken on a hedge at night, where at intervals it was giving its loud stridulation, which sound most resembles a harsh "tszzickk!"

Conocephalus gracillimus (Sc.).

Xiphidium gracillimum of authors.

Miami, Fla., March 28, 1910; 1 ♂, 3 n. (nymphs were exceedingly abundant.)

Homestead, Fla., March 17–19, 1910; 7 ♂, 3 ♀, 2 n. (nymphs were exceedingly abundant.)

Key Vaca, Fla., March 14, 1910; 1 n.

Boot Key, Fla., March 14, 1910; 1 n.

Key West, Fla., March 15, 1910; 1 n.

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[44] *Bost. Jn. Nat. Hist.*, Vol. VII, p. 447, 1862. (As the synonymous *Microcentrum thoracicum*.)

[45] These *Proceedings*, 1905, p. 42.

[46] *Can. Ent.*, XXXIX, p. 287, 1907.

These specimens show but little variation in size and almost none at all in coloration. The nymphs are easily recognized by the striking dark median bar and the very narrow fastigium. The present records carry the known range of the species out over the Keys, while it has been recorded from as far north as Tampa.

Both at Miami and Homestead the high grass on the everglades was swarming with nymphs of this species in all stages of development, but the few adults were secured only after strenuous and long-continued beating, and all proved to have reached maturity very recently. In this region the great majority of the individuals of this species probably reach maturity during the first part of April.

Atlanticus glaber n. sp.

This fine species differs from its nearest relative, *Atlanticus gibbosus*, in having a proportionately longer pronotum with the disk transversely more convex and subequal in width throughout, the caudal margin much narrower and more sharply rounded. The lateral carinæ of the pronotum differ in being parallel and of equal intensity throughout, while the median carina is faintly indicated throughout and more pronounced on the metazona. The caudal margins of the lateral lobes of the pronotum are much less sinuate. The abdomen above is much more distinctly tricarinate and the posterior femora are shorter and much less swollen on the basal half than in any other species of the genus. The cerci of the male are not at all like those of *A. gibbosus*, they somewhat resemble those of *A. pachymerus*, but are much stouter.

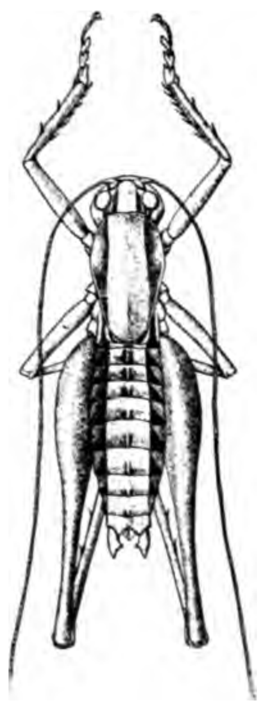

Fig. 20.—*Atlanticus glaber* n. sp. Dorsal view of type. (× 1¼.)

Type; ♂: Miami, Dade County, Fla., on narrow arm of the everglades sparsely overgrown with knee-high marsh grasses, March 28, 1910. (Hebard.) [Hebard Collection.]

Size not as large as *A. gibbosus*. Body slender and compressed for the genus. Head moderately large; fastigium broad, rounded, broader than first antennal

segment, not as broad proportionally as in *A. gibbosus*; eyes moderate, not prominent; antennæ long and slender, basally enlarged. Pronotum large, elongate, much more so than in any other of the three previously known species of the genus, produced caudad over the base of the tegmina, only the costal portion of the distal margin of the tegmina being visible from above; disk of the pronotum long, narrow, and convex, without transverse sulci, subequal in width, the cephalic margin subtruncate, the caudal margin strongly rotundato-arcuate. Tegmina extending to caudal margin of pronotal disk, the costal portion of the distal margin visible from above. Abdomen not so heavy as in *A. gibbosus*, distinctly tricarinate above. Cerci of the male short, heavy, subdepressed proximad, becoming strongly so distad, proximal portion subequal in width, distal section bluntly acute-angulate when seen from above; internal tooth placed slightly distad of the middle, short, sharp, slightly recurved. Spination as in *A. gibbosus* except in the case of the external margin of the posterior femora which are unarmed in the present species.

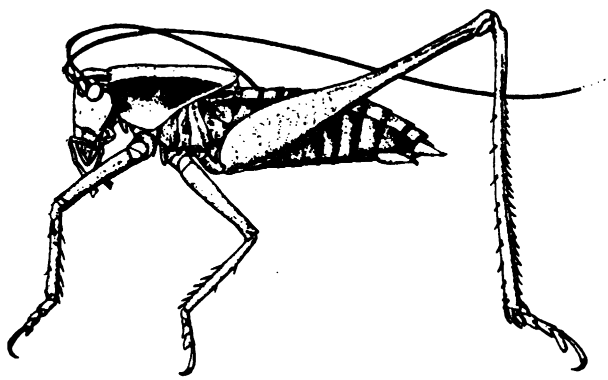

Fig. 21.—*Atlanticus glaber* n. sp. Lateral view of type. (× 1½.)

Allotypic ♀. Taken in the low undergrowth of the pine woods; other data the same as the type.

Very little larger than the male, tegmina wholly concealed, caudal limbs of the same general proportions, but slightly more elongate. Ovipositor over one-quarter shorter than the caudal femora, as heavy as in *A. gibbosus*, straight.

General color broccoli-brown, face and antennæ very light, broken blackish markings extend caudad from caudal margins of the antennal

scrobes and the adjacent portions of the eyes. The lateral lobes of the pronotum have the general pattern of coloration found in *Atlanticus* very pronounced, being shining black, bordered on the ventral margin with ivory-white, this border being wide cephalad, but narrowing sharply caudad; the entire cephalic portion of the lobes suffused with olive-gray. The sides of the abdomen are marked on the first seven segments with triangular shining black maculations, these are large cephalad, but rapidly decrease in size ventrad and terminate dorsad at the lateral carinæ and ventrad at the margin of the abdominal segment. The median carina of the abdomen is flecked with the same color, noticeably cephalad and gradually disappearing caudad until absent on the ninth abdominal segment. In coloration the female is very like the male except that the dorsal portion of the head, pronotum and abdomen is faintly streaked with bistre.

Fig. 22.—*Atlanticus glaber* n. sp. Outline of male cercus. × 6.

Measurements (*in millimeters*).

	Type.	Allotypic.
Length of body	31.5	32.5
Length of pronotum	11.5	11.8
Width of pronotum	4.1	4.1
Length of caudal femur	25.8	28.
Greatest width of caudal femur	4.4	4.9
Least width of caudal femur	1.5	1.5
Length of ovipositor		20.

In addition to the type and allotype we have the following specimens before us which may be considered paratypic:

Homestead, Fla., March 19, 1910; one nymph probably in the next to last nymphal stage.

Miami, Fla., March 28, 1910; one nymph in the same stage.

The specimens in the one-fourth grown condition taken at Miami, February 6–9, 1904, and the still more immature individual taken there on January 17, 1904, and recorded by the present authors as *Atlanticus* sp.,[47] are nymphs of the species here described.

All of the specimens of this species, with the exception of the male type, were taken in the low undergrowth of the pine woods, and there is every reason to believe that this environment is the favorite habitat of the species; the male type was captured while crossing

[47] These *Proceedings*, 1905, p. 48.

the previously mentioned narrow arm of the everglades from the fringing pine woods on one side to those on the opposite margin.

GRYLLIDÆ.

Scapteriscus abbreviatus Sc.

Key West, Fla., March 16, 1910; 2 ♀.

One of these specimens has the base color paler and more buffy than the other.

Both specimens were taken on the strand in burrows in the damp sand, exposed by overturning large coquina boulders lying among the growth of the plant *Borrichia fontescens*.

In addition to these specimens, we have examined the following in the United States National Museum:

Port Tampa, Fla., February 7, 1899 (Brenan); 3 ♂.
Miami, Fla., April 8, 1904 (J. A. McCrony); 2 ♀, 1 n.
Key West, Fla., May 23, 1911 (J. V. Harris); 1 ♂, 1 ♀.
White Oak, Ga., (A. S. Barnwell); 1 ♂, 1 ♀, 1 n.

The only previous record of the species from within the United States was Scudder's "Southern Florida" reference in his catalogue.

Ellipes minuta (Sc.).

Miami, Fla., March 27, 28, 1910; 1 ♂, 4 ♀, 5 n.
Homestead, Fla., March 18, 1910; 1 n.

The specimens from Miami were all taken in wet depressions in the pine woods, while the specimen from Homestead was captured in a pot-hole in the pine woods where a strawberry bed was situated.

Cryptoptilum antillarum (Redt.).

Miami, Fla. (Biscayne Bay), February 9, 1904; 1 ♂: (Slosson), 1 ♂, [Mus. Comp. Zool. Cambr.].
Key Largo, Fla., March 18, 1910; 1 ♀ n.
Long Key, Fla., March 13, 1910; 7 ♂, 5 ♀, 2 ♂ n., 2 ♀ n.
Key Vaca, Fla., March 14, 1910; 3 ♂, 3 ♀ n., 1 ♀ n.
Boot Key, Fla., March 14, 1910; 1 ♂.
Key West, Fla., January 19, 1904; 1 ♂, 2 ♀, 4 ♀ n.: March 15, 16, 1910; 9 ♂, 13 ♀, 3 ♂ n., 4 ♀ n.

This species and the specimens here listed have been recently treated in full by the authors.[48]

Cryptoptilum trigonipalpum R. and H.

Key Largo, Fla., March 18, 1910; 1 ♀, 3 ♂ n.

This recently described scarce species has been fully treated and field notes on the specimens here listed have been given by us.[49]

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[48] These *Proceedings*, 1912.
[49] These *Proceedings*, 1912.

Cycloptilum zebra (R. and H.).

Lake Worth, Fla., (Slosson); 1 ♂.
Miami, Fla., February 6, 1904; 1 ♂.
Long Key, Fla., March 13, 1910; 1 ♀.
Key West, Fla., March 15, 16, 1910; 4 ♂, 7 ♀, 3 n.

The authors have treated this species fully and have already discussed the specimens listed here.[50]

Nemobius fasciatus socius (Sc.).

Miami, Fla., March 28, 1910; 1 ♂.

Nemobius ambitiosus Sc.

Miami, Fla., March 20, 28, 1910; 2 ♂, 1 ♀, 5 n.
Homestead, Fla., March 17–19, 1910; 2 ♂, 2 ♀.

The entire series was taken in the undergrowth of the pine woods.

Nemobius cubensis Sauss.

Homestead, Fla., March 17–19, 1910; (macropterous) 3 ♂, 3 ♀; (brachypterous) 4 ♂, 12 ♀; 1 n.

These specimens agree with the authors' conception of the species. Saussure's description, although not fully adequate, is much more satisfactory than many later descriptions of species of *Nemobius*. The preponderance of brachypterous individuals in the present series is probably due to the fact that these specimens were taken in their natural environment and not attracted to light; in the latter case individuals of this genus are almost always found to be macropterous. Though the presence or absence of wings gives individuals of this species a very different general appearance, close examination fails to show the least difference in any other respect.

All of the specimens here treated were taken in the high grass growing on the everglades.

Nemobius carolinus Sc.

Homestead, Fla., March 17–19, 1910; 1 ♀.

The single specimen referred to this species was taken with the series of *N. cubensis;* it is brachypterous and exactly agrees in size and coloration with specimens of that form of *N. cubensis,* though easily separated by all the more important though less conspicuous characters.

Miogryllus saussurei (Sc.).

Homestead, Fla., March 17–19, 1910; 1 ♂, 1 ♀, 2 ♂ n., 1 ♀ n.
Key West, Fla., March 15, 1910; 1 ♀ n.

The individuals from Homestead were found under rubbish about

[50] These *Proceedings,* 1912.

a strawberry bed situated in a "pot-hole" in the pine woods, the specimens from Key West were taken from under coquina boulders and boards.

Gryllus firmus Sc.

Miami, Fla., March 27, 28, 1910; 5 ♂ n., 1 ♀ n.: November 15, 1911 (Englehardt); 1 ♀ n. [B. I.]
Homestead, Fla., March 17–19, 1910; 1 ♀ n.
Long Key, Fla., March 13, 1910; 1 ♂ n.
Key West, Fla., March 15, 16, 1910; 2 ♂, 3 ♀, 4 ♀ n.

The adults in this series are very small for the present species averaging 21.4 mm. (20 to 24 mm.) in length. The majority of the specimens taken at Key West were found in or near their holes situated in the short heavy grasses growing on the scant soil near depressions.

Gryllus rubens Sc.

Miami, Fla., March 27, 28, 1910; 2 ♂.
Homestead, Fla., March 17–19, 1910; 2 ♀ n.

The adults from Miami were captured in low grass growing in the grounds of the Royal Palm Hotel.

Gryllodes sigillatus (Walk.).

Miami, Fla., March 27, 28, 1910; 1 ♂, 1 ♀.
Long Key, Fla., March 13, 17, 1910; 2 ♂, 1 ♀ n.
Key Vaca, Fla., March 14, 1910; 2 ♀.

The entire series here recorded was captured in cracks and crevices about buildings. The species flourishes in or near human habitations, and, although probably brought to southern Florida in goods from the West Indies, it is now thoroughly established there. At Key Vaca a large colony was found between boards piled for building near the railroad station; so active were the insects and so numerous were the nymphs that in the collector's efforts to capture adults all but two females escaped.

Anaxipha pulicaria (Burmeister).

Key West, Fla., March 15, 1910; 1 ♀.

We are using the above name provisionally for this species, following Saussure in so doing, although we are not convinced that *Gryllus pulicarius*[51] Burmeister, from Jamaica, based on a twelve-word diagnosis, is the same as the present individual. There can be little doubt, however, that the insect described by Saussure[52] under Burmeister's name is the same as the present specimen.

[51] *Handb. der Entom.*, II, Abth. II, pt. 1, p. 732, 1838.
[52] *Miss. Sci. Mex., Rech. Zool., Orth.*, p. 371, pl. 7, fig. 1, 1874.

The specimen before us was taken in short, heavy grasses growing on the scant soil near a depression, where long continued search failed to reveal other individuals.

Cyrtoxipha gundlachi[58] Sauss.

Miami, Fla., March 20, 28, 1910; 2 ♂, 3 ♀, 1 n.
Key Largo, Fla., March 18, 1910; 1 ♂, 3 n.
Long Key, Fla., March 13, 1910; 1 ♀.
Key Vaca, Fla., March 14, 1910; 1 ♂, 2 ♀.
Key West, Fla., March 15, 16, 1910; 26 ♂, 18 ♀; April 6, 1903 (Schwarz); 1 ♀ [U. S. N. M.].

This species varies appreciably in size in both sexes, while the extent to which the caudal portion of the wings extends caudad of the tegmina varies from one-half to four-fifths of the length of the caudal femora. In all of the adults in the above extensive series the tympanum of the cephalic face of the cephalic tibiæ is distinctly indicated.

A single male from Punta Gorda, De Soto County, Fla., taken November 17, 1911, by W. T. Davis on mangrove (B. I.), is also before us. It is slightly smaller than the smallest of the present series, but otherwise shows no differences.

The series taken at Miami was captured by beating heavy foliage in "jungle growth"; on the Keys the species was found not uncommon on a great variety of bushes, vines and trees, many were beaten from *Ilex cassine*, while numbers were heard and some few taken from the foliage of the mangroves.

The sound produced by the males of this species is very delicate and high-pitched—a clear, tinkling note which is very pleasing.

Hapithus quadratus Sc.

Miami, Fla., March 28, 1910; 1 n: November 15, 1911 (Englehardt); 1 n. [B. I.]
Long Key, Fla., March 13, 1910; 1 ♂.
Key West, Fla., March 15, 16, 1910; 3 ♂, 2 ♀.

The adult specimens were all captured by beating low bushes, such as *Ilex cassine*, and high plants, while the nymph taken at Miami was found in the undergrowth of the pine woods.

[58] The record by the authors of *C. delicatula* Scudder, from Key West and Miami (these *Proceedings*, 1905, p. 51), is an erroneous identification of the present species. Since that date we have been able to examine the typical material of *C. delicatula* and ascertain its true relationship to the specimens in hand.

Orocharis saulcyi (Guérin).

Miami, Fla., March 28, 1910; 1 n.
Homestead, Fla., March 17–19, 1910; 2 n.
Key Largo, Fla., March 18, 1910; 1 ♂, 1 ♀, 3 n.

The adults were taken on Key Largo in the twilight of the heavy jungle growth, by vigorously beating the foliage of the lower limbs of the trees and the tangled grape and other vines.

During the winter months this species is one of the scarcest to be found in southern Florida, constant search for it during several winter collecting trips has resulted in the capture of but four adults.

Tafalisca lurida Walk.

Capron, Fla., April 7, 21; 2 ♀, 2 n. [U. S. N. M.]
Haulover, Fla.; 1 n. [U. S. N. M.]
Key Largo, Fla., March 18, 1910; 1 n.
Key West, Fla.; 1 n. [U. S. N. M.]

The nymph from Key Largo was taken in the same manner and situation as the specimens of *Orocharis saulcyi* from that locality.

STATISTICAL STUDIES ON VARIATION IN THE WING-LENGTH OF A BUTTERFLY OF THE SUBFAMILY SATYRINÆ.

BY T. FUKUDA.

As is well known, the distinction of sex, generation, or habitat in any species of butterfly may sometimes be a definite cause of the differences in size. The aim of the present report is to determine statistically the degree of such differences found under these circumstances.

MATERIAL.

Ypthima philomera var. *argus*, which I selected for the material of this work, is a small butterfly of the subfamily Satyrinæ commonly found in Japan. Judging from my observations and breeding experiments, this species most likely repeats its life-cycle three times during one year, at least in all the warmer districts of this country, the butterflies appearing in succession, April–May (first generation), June–July (second generation), and August–October (third generation). The details of the material are shown in Table I.

TABLE I.

Lot.	Male.	Female.	Date.	Locality.[1]
I	37	..	11–15, V, 1910	Kawanabé, Prov. Satsuma.
II	42		13–17, VII, "	" " "
III	57	36	20–24, IX, "	" " "
IV	53	30	20–24, VIII, 1909	Himeji, Prov. Harima.
V	45	....	28–30, VIII, 1910	" " "
VI	157	56	19–22, VIII, "	Tsumago, Prov. Shinano.

All the individuals of one and the same lot were captured by myself within an area about two miles in diameter. There is scarcely any doubt that Lots I–III belong to the corresponding generations of 1910, while Lots IV and V are most likely the representatives of the third. Having come from a comparatively cold district, Lot VI probably consists of the individuals of the second generation.

[1] Kawanabé, Prov. Satsuma, 20 miles south of Kagoshima, nearly at the southern extremity of Kiushiu; Himeji, Prov. Harima, 35 miles west of Kobé; Tsumago, Prov. Shinano, 60 miles northeast of Nagoya.

The Method of Measurement.

The method adopted in the measurement is as follows: the right fore wing of the butterfly, carefully removed from the body, is put upon the glass stage of a dissecting microscope and covered with a thin plate of mica; the mirror of the microscope is arranged to so reflect light from its surface as to make the outline of the wing clear; then the length from the base of the wing to the farthest point on its outer margin, without taking the length of the marginal hairs into account (this point is always a little behind the anterior angle), is measured with compasses from over the mica to the nearest half-millimeter.

The Differences Among the Means.

Table II shows how the variants of each lot are distributed through the classes, while in Table III are exhibited the means of measurements, the standard deviations, and the coefficients of variation with their probable errors. One may notice in these tables, but more clearly in Table IV, how some fairly considerable differences occur among the mean values of several measurements. These differences are always great enough to be considered significant, as they exceed three times the corresponding probable errors except in one case only (*a*) where two groups of males from the same locality and captured in the same season two successive years are to be compared with each other. It might be supposed that some intrinsic causes lying in the bodies of the animals must have had influence in determining the wing-length of the butterflies; but several external factors, too, *e.g.*, the temperature, the quantity of food, etc., working on the developing organisms surely have had some important share in it.

Table II.

Lot	Sex	No.	Class.												Mode.	Range.
			15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0		
I	♂	37	....	....	....	....	1	3	2	6	9	9	5	2	19.5, 20.0	17.5–21.0
II	♂	42	....	....	....	1	10	13	12	5	1	....	....	....	18.0	17.0–19.5
III	♂	57	1	1	5	16	20	11	3	....	....	....	....	....	17.5	15.5–18.5
III	♀	36	....	3	10	13	8	2	....	....	....	....	....	....	17.0	16.0–18.0
IV	♂	53	....	1	3	6	16	17	9	1	....	....	....	....	18.0	16.0–19.0
IV	♀	30	1	2	5	13	4	4	1	....	....	....	....	....	17.0	15.5–18.5
V	♂	45	....	....	1	6	13	16	9	....	....	....	....	....	18.0	16.5–18.5
VI	♀	157	....	....	1	1	11	29	50	37	22	4	2	....	18.5	16.5–20.5
VI	♀	56	....	....	2	4	9	22	7	8	3	1	....	....	18.0	16.5–20.0

TABLE III.

Lot.	Sex.	No.	Mean.	Standard Deviation.	Coefficient of Variability.
I	♂	37	19.527 ± 0.093	0.838 ± 0.066	4.29 ± 0.34
II	♂	42	18.155 ± 0.057	0.551 ± 0.041	3.03 ± 0.22
III	♂	57	17.360 ± 0.053	0.591 ± 0.037	3.40 ± 0.21
III	♀	36	16.944 ± 0.057	0.511 ± 0.041	3.01 ± 0.24
IV	♂	53	17.717 ± 0.057	0.611 ± 0.040	3.45 ± 0.23
IV	♀	30	17.050 ± 0.080	0.650 ± 0.057	3.81 ± 0.33
V	♂	45	17.789 ± 0.051	0.511 ± 0.036	2.87 ± 0.20
VI	♂	157	18.637 ± 0.036	0.667 ± 0.025	3.58 ± 0.14
VI	♀	56	18.116 ± 0.067	0.738 ± 0.047	4.07 ± 0.26

TABLE IV.

	Lots.	Difference.	%
a	V -IV ♂	0.072 ± 0.076	0.405
b	I -II	1.372 ± 0.109	7.026
c	II -III ♂	0.795 ± 0.078	4.379
d	VI ♂-II	0.482 ± 0.067	2.586
e	VI ♂-V	0.848 ± 0.062	4.550
f	V -III ♂	0.429 ± 0.074	2.412
g	III ♂-III ♀	0.416 ± 0.078	2.396
h	IV ♂-IV ♀	0.667 ± 0.095	2.795
i	VI ♂-VI ♂	0.521 ± 0.076	2.796

We can see (Lots I–III in Tables II, III, or *b*, *c* in Table IV) that the length of the fore wings of the male butterflies diminishes gradually as the season advances.

That this species winters over as caterpillars was ascertained in my breeding experiments, and that Lot I implies only the individuals which had hibernated during their caterpillar stages is scarcely doubtful, so I am inclined to attribute this difference (*b*) of the wing-length between this lot and Lot II to some such cause as mentioned by Standfuss,[2] *i.e.*, the difference in the length of the feeding period, which had happened to affect the developing organisms. The same rule has probably held in Case *c*. In the succeeding three cases, *d–f*, we can recognize how the length of the fore wings of the butterflies, even if of the same sex and generation, has the tendency to increase the more the latitude of their habitat increases.

Bachmetjew[3] has ascertained that the butterflies of this sub-

[2] Morgan, T. H., *Experimental Zoology*, 1907, pp. 24, 25.
[3] *Experimentelle Entomologische Studien*, II (1907).

family flying in Bulgaria, with a few exceptions, have greater wing-expansion than those of the same species found in Germany or in France. He attributes this to the difference of temperature. We have several other instances concerning the size of the butterflies of this subfamily diminishing gradually under comparatively high latitudes. All these instances are not in accordance with my result. In *g–i* once more we meet with such an instance of the differences in the wing-length as is opposed to the facts hitherto commonly acknowledged and especially to the results of observations made by Bachmetjew. On examining ten Bulgarian species of this subfamily, he has concluded that the wing-expansion of the females more or less exceeds that of the males. The case is quite the reverse with *Ypthima philomera* var. *argus*, the males having on an average longer fore wings than the females. It is true that this species shows a sexual difference in the shape of the fore wings, their anterior angles being a little more obtuse in females than in males; but this difference is never so great that it can reverse the situations of the two sexes. I cannot interpret the above-mentioned discrepancies between the present results and those hitherto obtained but to attribute them to the differences between the species.

The Standard Deviations and the Coefficients of Variabilities.

The standard deviations and the coefficients of variation do not represent anything as distinct as the case of means. They are fairly great, however, in Lot I, differing so much from those of Lot II or III as to claim to be considered probably significant; thus:

σ the difference between Lots I and II
0.287 ± 0.077

σ the difference between Lots I and III
$0.247 \pm 0.076.$

C the difference between Lots I and II
1.26 ± 0.40

C the difference between Lots I and III
0.89 ± 0.40

If we call to mind that the individuals included in Lot I are such as had distinctly longer caterpillar stages than in the other lots, this fact may deserve our special notice.

THE EXPERIMENTAL METHOD OF TESTING THE EFFICIENCY OF WARNING AND CRYPTIC COLORATION IN PROTECTING ANIMALS FROM THEIR ENEMIES.

BY W. L. MCATEE.

CONTENTS.

INTRODUCTION.

The selectionist theories regarding the significance and the causes of production of the so-called warning, mimicking, and cryptic coloration long preceded a knowledge of the food preferences of insectivorous animals sufficient to warrant such speculations. In fact, this knowledge is still almost entirely lacking for many parts of the world—including the Amazon valley, which is the home of the brightly colored Heliconiid butterflies and their mimics that suggested the mimicry theory to H. W. Bates. In 1861, Bates explained the numerous cases of mimicry of the butterflies of this family by butterflies and moths of at least five other families, by stating that the Heliconiidæ probably are unpalatable to insect enemies, and that the others disguised in their dress share this immunity.[1] He

[1] *Trans. Linn. Soc. Lond.*, XXIII, 1862, p. 510.

also proposed to explain cryptic resemblances, or the mimicry of inanimate objects by natural selection. Four years later, A. R. Wallace stated[2] that he agreed entirely with Bates as to the cause of mimicry, and cited many examples of the phenomenon from the Malayan region. In 1867 the same author first gave a definite theory[3] concerning the significance of the brilliant colors which are now commonly referred to as warning colors. In 1870[4] he extended the application of Bates' theory of cryptic and mimicking colors and advanced the results of experiments in support of the theory of warning colors.

It is not necessary at this time to trace the later development of the theory by Müller, Dixey, Poulton, and others. Suffice it to say that the original definite suggestion that conspicuous colors have been developed to advertise disagreeable qualities was the result of Wallace's cudgelling his brain at Darwin's instance, for an explanation of the coloration of certain insect larvæ, which obviously could not be accounted for by sexual selection. The theory has since been expanded to include conspicuous coloration in all groups of animals. A certain insect smells badly to man; is colored red and black, for example, it is conspicuous and nasty to us, hence it must be to insectivorous animals. Its striking color advertises its nauseous qualities and it is avoided after experience; in other words, is protected. So goes the original theory. Although it has been expanded to include all conspicuous forms, whether or not they are nauseous to man, its supporters seemingly find it impossible entirely to forsake the older anthropomorphic ground. Mimicry theories hold that a palatable form gains protection by resembling one of the conspicuous but nauseous ones, and that distasteful forms are mutually benefited by resemblance. Each of these theories, it may be repeated, was built up in the absence of evidence that the insects concerned were actually distasteful or palatable as claimed. This was the principal criticism made by the comparatively few who at the time dared question the all-sufficiency of natural selection, and it stands to-day the greatest obstacle to acceptance of the theories.

This criticism spurred the supporters of the theory to sporadic efforts to produce evidence in favor of their contentions. The favorite method of securing such evidence has been by experimenting with captive animals, and the principal body of alleged proof of the

[2] *Trans. Linn. Soc. Lond.*, XXV, 1866, pp. 19–22.
[3] *Proc. Ent. Soc. Lond.*, 1867, p. lxxxi.
[4] *Contributions to the Theory of Natural Selection*, 1870, Chap. III.

distastefulness of certain insects and the palatability of others consists of the results of experiments. The cry always is to test theories under experimental conditions, but there are many things which cannot be so tested. The very conditions of captivity and the limited choice of food constitute abnormalities which cannot fail to distort the food relations of most animals, and so modify the results of experiments that they bear little or no analogy to natural conditions.

In experiments play is allowed to the fancy of the experimenter, and the interpretation of facial and other expression of the subject has often been given more weight than the actual result of the experiment, that is, whether the insect was eaten or rejected. R. I. Pocock[5] very frankly admits this, saying, "It is quite clear that the plain record of an insect being eaten is no proof of its palatability. Better evidence on this head is supplied by the behavior of the bird towards it. After a little experience in the matter, I was able to satisfy myself, at all events, as to the approximate correctness of my interpretation of the bird's actions, and to judge thereby of the comparative palatability of the insects they tasted." This is honest confession at any rate, but the writer must take issue with this author as to the value of interpretation of behavior. "The plain record of an insect being eaten," which he holds up to scorn, may not show palatability, but shows something much more definite, namely, that the insect is acceptable food. Palatability in the sense used by some of the experimenters is entirely a figment of the imagination. This is proved by the many cases of refusal in captivity of insects which are eaten under natural conditions, and by the misinterpretation of the following among other features of the behavior of caged birds and other animals.

Wiping the bill or mouth: If a bird wipes its bill, or a lizard or frog its mouth, when it is being experimented with, the action is almost always credited as a sign of distaste. Yet nothing is more common than to see wild birds wiping their beaks across branches or other objects. It occurs at all times, apparently is often done in a purely mechanical way, and certainly has no essential connection with the taking of food or perception of tastes.

Dropping and picking up or in any way manipulating the prey is another thing usually taken as evidence of unpalatability, but nothing could be more at variance with conclusions drawn from

[5] *Proc. Zool. Soc. Lond.*, 1911, p. 810.

natural behavior. It is highly characteristic of many birds to thresh their prey about, and this is often continued until the object is broken in many pieces, which are separately swallowed. E. B. Poulton considered (*P. Z. S.*, 1887, p. 219) that a pupa would have been swallowed whole if palatable, but as it was crushed and the contents eaten it must have been unpalatable; and Weismann (*Studies in the Theory of Descent*, 1882, Vol. I, p. 341) thinks it readily conceivable that a certain caterpillar may not be unpalatable to lizards, because they swallow it whole, whilst it is perhaps distasteful to birds, because they must hack and tear it in order to swallow it. As a matter of fact, it is habitual for woodpeckers and jays to peck open pupæ and extract the contents, and smaller birds, as the chickadees and titmice, not only use this method when attacking pupæ, but for large larvæ also. Many birds hold the food between their feet and hammer it vigorously before eating, and others accomplish the same end by repeatedly picking it up and throwing it down. At least one experimenter, Jenner Weir, recognized such actions as natural, for he says, "All perfect Lepidoptera apparently require preparation before they are swallowed by birds; they are taken between the mandibles, shaken and bruised for a minute or two, and generally have the wings removed before they are eaten."[6] In many experiments, however, this same action is reckoned as a sign of disgust, if not as an actual rejection. Lizards habitually chew large prey before swallowing, snakes chew it or crush it by constriction; all of these actions are simply part of the normal preparation of food for deglutition, and in no sense of the word evidences of distaste.

Hesitancy and caution are usually translated as distaste. Does a bird of prey dislike the mouse it holds by a talon on its perch for hours at a time; does a butcherbird dislike the prey it impales on a thorn or wedges in a crotch for future reference? Does a cat play with a mouse because she hesitates to swallow so distasteful a creature? What animal does not employ dilatory tactics in feeding when it is not uncomfortably hungry? This subject naturally leads up to that of disregard, which may be looked upon as hesitancy prolonged.

Disregard may arise from many conditions, unrelated to the palatability of the food, such as varying appeal of the food to the captive animal according to its state of activity or health, or degree of hunger; or such as the size of the object offered, presence of the

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[6] *Trans. Ent. Soc. Lond.*, 1869, p. 22.

experimenter, or other disturbing elements. Disregard is a frequent phenomenon in experiments with birds of mixed feeding habits, which are most frequently used because more easily provided for in captivity. These birds have no great natural fondness for insects, and certainly not for adults of the order—Lepidoptera—most frequently used in the experiments. The insignificance of disregard is shown throughout Frank Finn's experiments, in the accounts of which (*Journ. Asiatic Soc. Bengal*, 1895, 1896, 1897), very common expressions concerning cases in which certain butterflies were not eaten in the presence of the experimenter are: "The butterflies were all gone later on," "Next day all the butterflies were gone," etc. In fact, more than 64 per cent. of the butterflies which were left in the cages were eaten in the absence of the experimenter, and more than 77 per cent. of those eaten belonged to the "nauseous" group. The experiments of S. D. Judd (see pp. 332–352) show that disregard bears no particular relation either to acceptances or to rejections, and certainly none to natural preferences. Thus, of the three categories of insects offered to the birds, namely, "warningly colored" insects, others "specially defended," and "non-protected" forms, practically the same proportions (17 to 19 per cent.) were rejected, while the percentage disregarded varied from 3 to 11.

In Poulton's tabulations of experiments (*P. Z. S.*, 1887) disregard is usually reckoned practically the same as a refusal. Indeed, the original tendency was to consider that disregard showed much greater distaste than any result following trial, for it is pointed out (pp. 193, 194) that the brilliant colors of caterpillars to be of value must generally prevent even trial, because of the fatal consequences to these larvæ of very slight wounds. However, Poulton states that out of thirty-seven cases in the "nauseous" group, fifteen were exposed to hungry animals, other food being withheld, and of the fifteen only three remained untasted. Of these two have been shown to be eaten under certain circumstances (p. 225). Poulton estimates disregard properly in one case, that of *Lasiocampa quercus* larvæ. These were disregarded by birds and lizards, and the comment on the evidence is, "Neutral as far as the adult larva is concerned" (p. 209). As a matter of fact, disregard is no more of neutral significance in this case than in the fifteen others in which disregard or disregard plus acceptance is the sole evidence upon which proof of distastefulness is claimed. The fact that nine of the eighteen insects of the "unpalatable" group are known to be eaten by wild

British birds further suggests the unreliability of disregard as a guide to natural tastes.

In consequence of the too great fondness of some experimenters for psychological deductions, the writer, in judging experiments, has separated "disregards" for the reasons above stated, and has taken cognizance only of rejections that resulted from actual trial. But a rejection has been credited for each time the experimenter says the object was refused, even if it was eaten later. This is certainly as great a concession in favor of the experiments as can be expected from one who believes not at all in their utility. Tabulations have been made anew (whenever possible) from the detailed accounts of the experiments. It cannot be hoped that these are free from error, but it may properly be assumed that they are approximately correct.

The earlier experiments especially are characterized by the average small number of tests of the various insects. For this reason, single or a very few acceptances or refusals have been held to prove the palatability or otherwise of a certain form. Thus in the eyes of those who had faith in experiments, results piled up in a really beautiful way. It is not out of order, however, to point out in advance that there are many inconsistencies between the various sets of experiments and that these show that conclusions based upon a few trials are extremely liable to be overturned.

An interesting case showing the danger of basing conclusions upon a single rejection is given by Jenner Weir (*Trans. Ent. Soc. London*, 1869, p. 22): "The imago of *Spilosoma menthastri* . . . . was tasted by the reed bunting, but not relished, and soon dropped; the . . . . bird, however, attracted by the fluttering insect, returned to it, and ultimately swallowed it." If the insect had been taken out, the single rejection would, of course, have stood as the reed bunting's record. A case illustrating the possibilities of single acceptances or rejections is R. I. Pocock's experiment on "the distastefulness of *Anosia plexippus*" (*Nature*, 87, 1911, pp. 484–485). A specimen was offered to eleven species of birds and refused a total of thirteen times by them, before it was offered to a tinamou, which swallowed it at once. Reversing the experiment thus might have given an exactly opposite impression of the palatability of this insect.

In the following pages the expressions accepted, rejected, and disregarded are often abbreviated to A, R, and D, respectively. In general, the experiments are reviewed in groups determined by the classes of animals tested.

Experiments with Invertebrates (Chiefly Insects).

Since Professor E. B. Poulton,[7] the most prominent supporter of the theories of warning and mimicking coloration, has come to the conclusion, from proper data—that is, records of insects collected with naturally captured prey—that predaceous insects in general are enemies of the "specially protected" groups, it is not necessary to review experiments relating to the food preferences of insects. It is worthy of note, however, that some of these experiments have often been quoted as affording support to the prevailing theories. Poulton's latest conclusion is proof, therefore, that even the ardent believers in the experimental method admit that an "ounce" of proof as to natural behavior is worth a "pound" of experimental evidence.

An annotated bibliography of experiments upon invertebrates is given for the benefit of those who may desire to consult the original accounts. Those entries marked with an asterisk denote experiments which were not undertaken with a view to testing protective adaptations.

Barlow, Edward. A short note on the Food-insects of the Mantis *Heirodula bipapilla* Serv. *Proc. Asiatic Soc. Bengal*, December, 1894 (1895), pp. 138–139.

Ate *Musca*, *Lucilia*, and its own species, and killed but did not eat the Hemiptera, *Cyclopelia* and *Physomerus*.

Belt, Thomas. *The Naturalist in Nicaragua*. London, 1888.

Experiments with Heliconii. "A large species of spider (*Nephila*) . . . . used to drop them out of its web when I put them into it. Another spider that frequented flowers seemed to be fond of them, and I have already mentioned a wasp that caught them to store its nest with" (p. 317).

Butler, A. G. Remarks upon certain Caterpillars, etc., which are unpalatable to their enemies. *Trans. Ent. Soc. Lond.*, 1869, pp. 27–29.

Spiders (*Ereiba diadema* and *Lycosa*) rejected larvæ of *Abraxas grossulariata* and *Halia wauaria* (p. 28).

Embody, G. C. [Food of fresh-water Amphipods in aquaria]. Sonderabdruck aus *Internat. Rev. d. ges. Hydrobiologie u. Hydrographie*, Biol. Suppl., III, 1911 (1912), pp. 4–6.

Freshly killed isopods, snails, earthworms, tadpoles, and bits of fish, and beef were eaten, but planaria were refused.

[Food of Hydra] p. 31.

Young *Hyalella* and *Eucrangonyx* were eaten.

Marshall, G. A. K., and Poulton, E. B. *Trans. Ent. Soc. Lond.*, 1902.

[7] See *Trans. Ent. Soc. Lond.*, 1906, pp. 363, 364, 401, 403, and 408.

Experiments on Mantidæ in Natal and Rhodesia (G. A. K. M.), pp. 297–313.

[Summary of these experiments] (E. B. P.), pp. 313–315.

Conclusions from experiments on Mantidæ (E. B. P.), pp. 315–319.

"We may safely conclude that outside the Acræinæ, and doubtfully the Danainæ, Mantidæ devour butterflies very freely, the species with warning colors as well as the others, and that they are far more indiscriminating than the majority of insect-eaters" (p. 316). "But Mr. Marshall's experiments yielded plenty of evidence of the positive refusal and acceptance, as it were, under protest of Acræinæ, so that there can be no doubt of their distastefulness to this class of enemy" (p. 317).

Despite this conclusion, the fact remains that these Mantidæ ate more Acræinæ than they rejected upon trial, and rejected no Danainæ. It should be noted, furthermore, that many of the rejections occurred in the last day or two of the life of the various individual mantids when no food whatever was taken.

Experiments on spiders in the Karkloof (G. A. K. M.), pp. 319–322.

Results of experiments on spiders and the earlier experiments on Mantidæ: one probable meaning of tenacity of life in distasteful insects (G. A. K. M.) pp. 322–325, (E. B. P.) pp. 325–328.

"Experiments have convinced me that both spiders and mantises have no appreciation of warning colors" (p. 322). "It is quite probable . . . . that certain species of spiders, together with mantides and other predaceous insects, will be found among the chief, perhaps the chief, non-parasitic enemies of aposematic insects" (p. 327).

MARSHALL, G. F. L., and DE NICEVILLE, L. *The Butterflies of India, Burmah and Ceylon*, Calcutta, 1882–83.

"Mr. de Niceville has experimented with the carnivorous *Mantis* on many of the butterflies believed to be offensive to birds, and he has found *A. violæ* is the only butterfly which all the species of *Mantis* he has experimented with refuse to eat" (p. 318). This is all there is on the experiments.

MEISNER, OTTO. [Food of an Ant-lion and a Clerid in confinement.] *Ent. Bl.* Nürnberg, 5, Nr. 9, September 20, 1909, pp. 181 and 182.

A larva of the ant-lion (*Myrmeleon*) which had been fed only upon flies and caterpillars for a long time, afterwards rejected ants. A *Clerus formicarius* ate every *Adalia bipunctata* which got into its cage.

*PATCH, E. M. Predaceous Beetles and hibernating Insects. *Bul. 148, Maine Agr. Exp. Sta.*, November, 1907, pp. 273–276.

Pterostichus lucublandus was tested with numerous specimens of *Corimelæna pulicaria*, *Cosmopepla carnifex*, *Lygus pratensis*, and one *Serica vespertina*, all of which were eaten. Staphylinidæ were tested with the *Corimelæna*, *Lygus*, *Cosmopepla* and cutworms with same result.

PECKHAM, E. G. [Food of spiders and ants in captivity.] *Occas. Papers Nat. Hist. Soc. Wis.*, I, 1889, pp. 107, 109, 110.

Attidæ devoured flies, gnats, larvæ and other spiders, but would not touch ants. *Synageles picata* and *Synemosyna formica* are always hungry for gnats, but will not eat ants (p. 107). Ants devoured an ant-like spider, *Herpyllus*, which was placed in a vial with them (p. 109).

*Peckham, G. W. and E. G. The Sense of Sight in Spiders with some observations on the Color Sense. *Trans. Wis. Acad. Sci.*, X, 1894-5, pp. 231-261.

Remarks on food taken in captivity, but nothing in relation to protective adaptations of prey.

Plateau, Felix. Observations et experiences sur les moyens de protection de l'Abraxas grossulariata L. *Mem. de la. Soc. Zool. de France*, VII, 1894, pp. 375-392, 3 figs.

Experiences avec Araignees, pp. 385-388.

Spiders, *Amaurobius ferox*, and *Agalena labyrinthica* would not touch the larva of *Abraxas*. *Tegenaria domestica* attacked the larva, but could not pierce its tough skin. Both *Tegenaria* and *Epeira diadema* ate imagos, while *Agalena* rejected them.

Experiences avec Carabes et Dytiques, pp. 388-390.

Carabus auratus, *Dytiscus marginatus*, and *D. dimidiatus* freely devoured *Abraxas* larvæ.

*Pocock, R. I. Notes upon the habits of some living Scorpions. *Nature*, 48, 1893, pp. 104-107.

They ate cockroaches, blue-bottle flies, etc., in captivity.

Pocock, R. I. Further notes and observations on the instincts of some common English Spiders. *Nature*, 49, 1893, pp. 61-63.

It was found that the prey of *Agalena labyrinthica* consists largely of bees. A *Bombus* put in a web was enshrouded before it was killed; a blue-bottle fly was pounced upon at once, while a drone-fly (*Eristalis*) was cautiously attacked and killed, but not enshrouded.

*Porter, J. B. The habits, instincts, and mental powers of Spiders, genera, Argiope and Epeira. *Amer. Journ. of Psychology*, 17, 1906, pp. 306-357.

Experiments with food, but not in relation to protective adaptations, are described on pp. 334-338.

Experiments with Vertebrates.

FISHES.

In a paper entitled, "An Experimental Field-study of Warning Coloration in Coral-reef Fishes,"[8] Prof. Jacob Reighard records a variety of experiments to determine the significance of colors and flavors of prey to gray snappers (*Lutianus griseus*). The predaceous fishes were free and under normal conditions. The common prey

[8] Papers from the Tortugas Laboratory, *Carnegie Institution*, Vol. II, 1908, No. 9, pp. 257-325.

of this species at the time of the tests was found to be the sardine (*Atherina laticeps*), a silvery fish that could readily be stained any color. A large number of *Atherina* stained vermilion, yellow, green, blue, or purple were eaten practically as rapidly as fed. Others dyed and treated with formic acid, formaldehyde, red pepper, quinine, ammonia, or carbon bisulphid were taken with equal readiness. *Atherina* were made unpalatable, however, by sewing in their mouths bits of the tentacles of medusæ, and an association of this unpalatability with a color (red) was established in the individuals of a colony of 150 snappers. The association was found to persist at least five weeks.

The brightly colored fishes of the coral reefs were then offered to the snappers, and they attempted to capture all offered, and actually did take all but one species, of which the single large specimen offered escaped. The species taken were of a variety of colors, including colors and patterns considered as typically warning. In several species "conspicuousness is combined with unpleasant attributes in the form of defensive spines, the typical warning combination, yet these fish were all instantly taken" (p. 303).

It was further found "that the gray snapper discriminates with great rapidity and delicacy between the various possible food elements of its environment, which are not conspicuously different from each other," thus proving that the bright colors of the reef fishes would be unnecessary even were their possessors unpalatable.

Hence "the conclusion is reached that the conspicuousness of coral-reef fishes, since it is not a secondary sexual character and has no necessary meaning for protection, aggression, or as warning, is without biological significance" (p. 320).

AMPHIBIA.

In Countries Other than the United States.

Experiments dealing chiefly with Amphibia are few. Those of Poulton with *Hyla*[9] are cited in another place. A. G. Butler, Eltringham, Plateau, and Finn also record short experiments with animals of this class. Butler published[10] the fact that he had found the larvæ of *Abraxas grossulariata, Halia wauaria,* and a sawfly, all fed upon gooseberry, to be distasteful to frogs (and lizards). He asks: "May it not be possible that the plant transmits some pecu-

[9] *Proc. Zool. Soc. Lond.*, 1887, pp. 269–274.
[10] *Ent. Monthly Mag.* 5, 1868, pp. 131–132.

liar acid to the larvæ which feed upon it, such as to cause their rejection as food by small reptiles, etc.?"

Plateau found that *Rana temporaria* and *Triton punctatus* rejected, while *Triton alpestris* disregarded the larvæ of *Abraxas*.[11] Eltringham cites a very few tests made with a salamander. The animal accepted earthworms and honey bees, and disregarded larvæ of *Pieris brassicæ*.[12] Finn found that the Indian bull-frog (*Rana tigrina*)[13] took all butterflies offered to it, except two *Danais chrysippus*, of which species it ate one.

In the United States.

A number of experiments upon Amphibia have been performed in the United States. These are discussed in two groups, those on toads and those on frogs.

TOADS.—In company with Dr. A. K. Fisher, the writer once attempted to give a toad (*Bufo lentiginosus*) his fill of hymenopterous food. This occurred on Plummer's Island, Md., about 1905. Honey bees and wasps of the genera *Polistes*, *Sceliphron*, and *Vespa* were captured, their wings were clipped, and they were put down so that they would crawl in front of the toad, which was partially domesticated about the cabin and was not much disturbed by the movements of humans. The toad took every insect offered, although at times he showed considerable but ludicrous signs of discomfort. Not less than 30, and perhaps as many as 40 Hymenoptera were taken by this animal in about an hour. He finally left the spot, apparently to get away from a locality characterized by such extremely spicy food, which nevertheless he was apparently unable to refuse.

In another experiment performed by the writer at the same locality, on August 6, 1911, another toad was also fed *Polistes*, *Pelopæus*, and another stinging wasp, none of which was refused. A sphinx moth, a small white moth, several ants and flies also were taken. The toad attempted to eat a katydid (*Cyrtophyllus perspicillatus*), but found it too large. A small *Heterocampa* larva, colored green and red, was eaten, and then a *Julus* was put before him. As soon as it began to crawl he seized it by one end and, not getting a good hold, ejected it. It then crawled over his head. This might be construed by some as evidence of dislike, but I think that if the *Julus* had been fairly seized it would have gone down. At any rate the case well

[11] *Mém. de la Soc. Zool. de France*, VII, 1894, pp. 383, 384.
[12] *Trans. Ent. Soc. Lond.*, 1909, pp. 473, 474.
[13] *Journ. Asiatic Soc. Bengal*, 66, 1897 (1898), p. 533.

illustrates the danger of drawing conclusions from scanty experimenting, for stomach examinations show *Julus* to be a favorite food with toads. A. H. Kirkland says in his valuable paper on the economic value of the toad:[14] "Myriapods form a constant article of diet for the toad. Species of the genus *Julus* were present in the majority of the stomachs examined, the largest number found in a single stomach being seventy-seven. These creatures form 10 per cent. of the food for the season."

Mr. Kirkland's examinations of stomachs serve to check another set of experiments which is claimed to show that squash bugs (*Anasa tristis*) are seldom eaten by toads. The account of these experiments by C. M. Weed and Albert F. Conradi is as follows:

"The common toad has been generally considered an enemy of the squash bug, being frequently referred to in this connection in articles concerning the pest. We made a large number of observations on this phase of the subject, the most interesting result being the discovery that the odor given off by the bugs will actually kill toads if confined in a small open vessel, such as a wide-mouthed bottle. Some of these experiments as recorded in a published letter by Mr. Conradi are as follows:[15] When a squash-bug nymph of the fifth stage was suddenly introduced into a half-pint, open, wide-mouthed bottle containing a half-grown, live toad, so that the batrachian would get the full effects of the pungent fumes secreted by the bug, the toad was thrown into a temporary stupor, the effect being similar to that of chloroform. As the number of bugs was increased, the effect on the toad was increased. When as many as seven bugs were introduced, the toad fell into a profound stupor, from the effects of which it died in the course of twenty-four hours.

"On September 8, an adult toad that had been kept in the laboratory vivarium with a scant food supply for several days, was placed in a quart jar of the same construction as the one mentioned above, and eight bugs were introduced; these bugs, however, had been so much disturbed previously that the source of the pungent secretion had been temporarily exhausted. The toad hesitatingly devoured three, after which she would remove with her front feet every specimen that made an attempt to ascend the wall of her enclosure; but these bugs were not eaten. The toad was then transferred to another jar of the same size and construction, and eight bugs were suddenly

[14] *Bul. 46, Hatch Exp. Sta.*, 1897, p. 15.

[15] *Science*, N. S., Vol. XIV, No. 360, November 22, 1901, pp. 816, 817. See also *Science*, N. S., Vol, XIX, No. 479, March 4, 1904, pp. 393, 394.

introduced from the squash leaf so that the animal would get the first and fullest effects of the odor; the result was that the toad went through a series of contortions followed by a short period of stupor similar to that mentioned before. Upon recovery the toad was again removed to the vivarium, where it now lives in partial hibernation.

"A young, red-spotted salamander was affected and killed as easily as the half-grown toad, while for the common field frog a greater number of bugs were required to bring about similar effects, the frogs also being killed. Many experiments with snakes were tried, but no ill effects from the secretion of the bugs were apparent.

"The odor that the bug secretes is contained in a clear, slightly greenish liquid expelled from the extremity of the alimentary canal; when it comes in contact with the air the odor is given off almost instantaneously while the liquid remains to evaporate.

"Further observations showed that toads in confinement would eat squash bugs when very hungry, but we do not think that toads ordinarily devour many of the pests."[16]

It is most obvious that the conditions of these experiments are never even faintly simulated under natural conditions. The conclusions in the last paragraph, being based on the results of the experiments, are therefore unwarranted. Moreover, they do not agree with the statements of other observers relating to the habits of the toad under normal conditions. Kirkland found *Anasa tristis* in collected stomachs,[17] as did also Judd and the writer.

Kirkland briefly records an experiment of his own as follows:

"The writer once confined for study a large toad in a shaded out-of-door box filled with damp earth. To provide suitable and sufficient food for it was quite a task until an entirely satisfactory expedient suggested itself. A hard bread-crust was soaked in molasses and placed in the cage. Bees, wasps, ants, flies, and beetles came to this bait, and it was most interesting to watch the toad seize the flying insects, often before they had alighted on the bread. Stinging insects, bees, wasps, etc., when swallowed by the toad apparently produced uncomfortable sensations for a short time. Fish-worms when captured by the toad often prove too much to be swallowed at once, and when this is the case the fore limbs are brought

[16] "The Squash Bug," *Bull. 89, New Hampshire Agric. Exp. Sta.*, February, 1902, pp. 21–23.

[17] *Bul. 46, Hatch Exp. Sta.*, 1897, p. 26.

into use to force the unfortunate worm into the capacious gullet of its captor."[18]

In this connection we may quote C. F. Hodge,[19] who, in giving instructions as to the use of toads as insect catchers in houses, says: "Sugar solutions should not be used [as bait] on account of the danger to honey bees which a toad will take in great numbers despite their stings." Hodge quotes[20] a feeding test by Miss E. M. Foskett, the insect used being *Macrodactylus subspinosus*. Miss Foskett says: "One day I gathered a quantity of rose bugs in a tin box, sat down in the shade beside my queer pet and began feeding bugs to him. At first I did not count, but finding his appetite so good, I started to count. When I had counted over eighty bugs and the toad showed no signs of wishing to conclude his meal, I picked him up. . . . . Previous to my beginning to count, he had taken anywhere from ten to twenty bugs. He was quite a large toad, but the bugs were large, too, and very 'scratchy.'"

The American Sportsman (Vol. 3, No. 2, October 11, 1873, p. 23) reports a series of experiments with toads by Dr. Thomas Hill. This account does not have a thoroughgoing appearance of verity, but this may be not a reflection on the experiments themselves, but upon the reporting. It is said a toad ate "yellow-striped" locusts, earthworms, and at one meal twenty-three squash bugs and ninety-four larvæ of *Pygæra menistra* [*Datana ministra*].

C. V. Riley briefly states[21] the results of offering larvæ of *Anosia plexippus* to various animals, as follows: "Prompted by . . . . experiments made in England, I was led to make similar ones with our gayly colored Archippus larva, and the result fully accords with that obtained by Mr. Weir, for neither turkeys, chickens, toads, nor snakes would touch it."

Included with some notes on the Florida chameleon (*Anolis principalis*), Dr. S. Lockwood records[22] an observation upon captive toads. Two of these animals ate, respectively, three and two potato beetles (*Leptinotarsa decemlineata*), after which they would take no more. Dr. Lockwood then remarks: "It was specially observable of the one which had swallowed the three spearmen, despite the grotesque gravity of his demeanor, that there was a certain dolorous

[18] *L.c.*, p. 11.
[19] *Nature Study Leaflet, Biol. Ser. I*, Worcester, Mass., 1898, p. 11.
[20] *L. c.*, p. 10.
[21] *Third Ann. Rep. on the Insects of Missouri*, 1871, p. 148.
[22] *Am. Nat.*, 10, 1876, p. 8.

air about him, as of one suffering from an overdose of Doryphora. Though kept some two weeks with no other food, neither Bufo would touch a spearman again."

No better illustration could be asked of the misleading character of experimental results nor, it may be added, of the highly imaginative conclusions drawn therefrom. Notwithstanding the "dolorous air" of these toads by reason of potato-beetle diet, the fact remains that toads habitually feed on potato beetles. Tenney,[23] Riley,[24] Kirkland,[25] Garman,[26] and Chittenden[27] among others record toads as enemies of potato beetles. The writer has found the remains of no fewer than twelve *Leptinotarsa decemlineata* in a single casting of a toad.

FROGS.—In an article entitled, "Habit Formation in Frogs,"[28] A. A. Schaeffer says: "Individuals of three different species of frogs, *Rana clamata*, *R. sylvatica*, and *R. virescens* learned to avoid disagreeable objects, such as hairy caterpillars, in from four to seven trials or possibly less. Such habits persisted for at least ten days, but this point was not thoroughly tested.

A *Rana clamata* formed a habit of avoiding earthworms treated with chemicals in two trials. This habit persisted perfectly for only a short time, covering five trials in about twenty-two hours. The habit persisted somewhat imperfectly for five days. After an electric stimulus had been applied, earthworms were not eaten for seven days, although mealworms were eaten" (p. 334).

These observations point to the conclusion that any color may be regarded as warning, provided a sufficiently disagreeable impression becomes associated with it.

Another experimenter, Charles W. Hargitt, was led to doubt the quick formation of such associations by *Hyla*, as is shown by his comments on the behavior of a tree frog toward Hymenoptera. In food taking, he says: "Hyla behaves quite similarly to others of its kind. It seems not to notice any except moving objects. A spider may remain quietly in a given part of the cage for hours or days undisturbed. If it assume an active attitude it is almost certain to be taken very promptly. It is thus with any prey. The insects most commonly supplied were flies, small beetles, grass-

[23] *Amer. Nat.*, 5, 1871, pp. 170, 171.
[24] *Fourth Mo. Rep.*, 1872, p. 16, and in many other publications.
[25] *Bul. 46, Hatch Agr. Exp. Sta.*, 1897, p. 25.
[26] *Bul. 91, Ky. Agr. Exp. Sta.*, 1901, p. 66.
[27] *Circ. 87, U. S. Bur. Ent.*, 1907, p. 12.
[28] *Journ. An. Behavior.*, Vol. 1, No. 5, Sept.–Oct., 1911, pp. 309–335.

hoppers, spiders, etc. On one occasion a small wasp was released in the cage and at once began to buzz about or run up the sides of the cage actively. It was but a few moments ere a specimen leaped eagerly and captured the prey. Then a most interesting performance took place. No sooner was the wasp seized than it was whipped into the mouth, and in turn stung the frog; the frog in turn showed a very lively appreciation of that fact, and made an apparent effort to eject the creature; but the process of ingestion had gone too far and deglutition was completed without further ado, nor did the frog show the least further sign of distress. On another day the operation was repeated and very much after the fashion of the preceding. It may be doubted whether Amphibia show any particular discrimination based on that type of experience."[29]

SALAMANDERS.—Albert M. Reese, in a paper on the "Food and Chemical Reactions of the Spotted Newt, *Diemyctylus viridescens*," says that the animals show no difference in reaction toward bits of raw meat and earthworms nor to the juices from these substances.[30]

A specimen of hellbender (*Cryptobranchus allegheniensis*) which ejected remains of a crawfish soon after capture, refused to eat any of these animals placed in its aquarium later.[31]

REPTILES.

Experiments in Asia.

Among Frank Finn's many experimental contributions to the theory of natural selection are two which deal with the food taken by lizards. The first[32] deals with the Indian lizard (*Calotes versicolor*), both captive and free individuals of which were offered a variety of adult Lepidoptera. The results of feedings of the free and confined individuals agree very well except in the case of butterflies of the genus *Euplœa*. The record for these insects with lizards in a cage is A 4 R 1, and with those unconfined, A 1 R 4. Species of *Danais*, *Delias eucharis*, and *Papilio aristolochiæ* were freely eaten, and Finn concludes: "The behavior of these reptiles certainly does not appear to afford support to the belief that the butterflies, at any rate, usually considered nauseous, are distasteful to them" (p. 48).

The second series of experiments we refer to are reported in

[29] "Behavior and Color Changes of Tree Frogs," *Journal of Animal Behavior*, Vol. 2, No. 1, Jan.-Feb., 1912, pp. 53, 54.
[30] *Journ. Animal Behavior*, Vol. 2, No. 3, May-June, 1912, p. 207.
[31] "Oconomowoc," *Forest and Stream*, 8, No. 20, June 21, 1877, p. 320.
[32] *Journ. Asiatic Soc. Bengal*, 65, 1896 (1897), pp. 42-48.

Natural Science, December, 1892.[33] They deal chiefly with the East African lizards, *Mabuia striata* and *Hemidactylus mabuia*. Several presumably distasteful insects were refused by these species. They refused wood lice also, which were eaten, however, by *Gerrhosaurus major*.

Experiments to determine the tastes of *Calotes* were also performed by R. C. Punnett in Ceylon.[34] Punnett concludes that the lizard tested (in confinement) by him showed no discrimination in the choice of various adult Lepidoptera offered. "The presumably distasteful *Danais* was eaten before the presumably palatable *Euschema* or *Mycalesis*, and the so-called distasteful *Euplœa* was taken before the supposedly palatable *Junonia iphita* of not very dissimilar coloration. Nor was any hesitation manifested towards *Papilio aristolochiæ* with its postulated evil taste and marked warning coloration" (p. 13). Punnett also found the larvæ of the last-named insect as well as an adult *Danais plexippus* were eaten by another lizard (*Lyriocephalus*). "From such experiments as these one can hardly fail to draw the conclusion that *Calotes* as well as *Lyriocephalus* will readily eat anything in the way of butterflies that they come across. Nor is this surprising, in view of the fact that such noxious creatures as the large ant (*Œcophylla smaragdina*) and hairy caterpillars constitute a considerable proportion of the contents of their stomachs. They certainly do not appear to exercise that nice discrimination with regard to butterflies, which is necessary for the establishment of mimicking forms on the theory of natural selection" (p. 13).

Lieut.-Col. Neville Manders also performed experiments with lizards[35] in Ceylon, using the following species: *Calotes versicolor*, *C. ophiomachus*, *C. nigrilabris*, *C. zeylanica*, and *Ceratophora stoddarti*. The last two species are smaller than the others and would not try to eat butterflies either when caged or free. The experiments with free specimens of the other three species resulted as follows: Lepidoptera classed as edible, A 11; Lepidoptera classed as nauseous, A 17 R 3. Manders says one of the latter was at first refused because of large size, then partly eaten, and the other two were too dry.

He further states "that so long as the butterflies remained perfectly still, they were entirely unnoticed by the lizards, though they might be in close proximity to them" (p. 708). This indicates that

[33] *I, No. 10*, pp. 746, 747.
[34] *Spolia zeylanica*, VII, Pt. XXV, September, 1910, pp. 12, 13.
[35] *Proc. Zool. Soc. Lond.*, 1911, pp. 707–710.

color is not the stimulus to capture, but that motion is. Manders concludes: "It would seem that those who assume that reptiles take no part in the production of Batesian or Müllerian mimicry are correct, though further experiments are required" (p. 710).

Experiments in Europe.

A series of experiments by H. Eltringham with *Lacerta viridis*[36] have as their main point the demonstration that a certain lepidopterous larva (*Boarmia rhomboidaria*), was more distasteful to the captive lizards when it had fed on ivy than when fed on apple. In addition, a number of other insects and other invertebrates were used in the experiments. No general conclusions are given. Possible comparisons with Poulton's tables of experiments (1887) are as follows:

	Poulton's tables, 1887.	Eltringham.	Animal tested.
Pieris brassicæ, larva	R.	A 4 D.	*Lacerta viridis*.
Apis mellifera	A many.	R.	" "

Later, Eltringham says that the caterpillars referred to in his previous experiments are not *Boarmia rhomboidaria*, but *Odontoptera bidentata*. The adult moths were eaten by lizards, to which they were fed by Messrs. Eltringham and Pocock. The latter found that they were acceptable also to a bird, *Graculifera melanoptera*. Eltringham concludes that the distastefulness of the larvæ was not intrinsic, but due to the character of the food in their digestive tracts.[37]

Plateau states[38] that seven *Cistudo europœa* ignored the caterpillar of *Abraxas grossulariata*, while one tried and rejected it. *Coluber æsculapii* and *Lacerta muralis* disregarded the larvæ and rejected them when placed in their mouths.

Experiments in America.

Few experimental tests of the efficiency of the protective adaptations of insects have been made in the United States. The most important series hitherto published in full was performed by Annie H. Pritchett and was reported in the *Biological Bulletin* (Vol. 5, pp. 271–287, 1903). The animals used were *Sceloporus floridanus*, *Gerrhonotus infernalis*, *Crotaphytus collaris*, *Cnemidophorus sexli-*

[36] *Trans. Ent. Soc. Lond.*, 1909, pp. 471–478.
[37] "Edibility of Lepidopterous Larvæ," *Proc. Ent. Soc. Lond.*, 1910, pp. xxxi, xxxii.
[38] *Mém. de la Soc. Zool. de France*, VII, 1894, p. 383.

neatus, *Eumeces* sp., and *Phrynosoma cornutum*. A large variety of invertebrates were offered the lizards, with the following principal results: (*a*) Only one instance of a lizard eating a dead insect; (*b*) insects that move slowly do not attract the attention of the lizard so much as do the more active forms, hence those that remain quiescent are rarely even attacked; (*c*) insects below a certain size are apparently not perceived by the large species of lizards; (*d*) large beetles having hard elytra are seldom eaten; (*e*) the myriapod *Julus* was not eaten by any lizard; (*f*) although the combinations of black and yellow, black and orange, or black and red are supposed to serve the purpose of warning coloration, all insects possessing these colors were, at one time or another, eaten, with the possible exceptions of *Panorpa nuptialis* Gerst. and a malodorous Lygæid bug.

Some experiments with *Sceloporus undulatus* by Dr. S. D. Judd which have never been published may now be put on record for purposes of comparison with the series just noted. The results of these tests follow:

ORTHOPTERA:	
BLATTIDÆ—*Stylopyga orientalis* (black)	A 2
MANTIDÆ—*Stagomantis carolina* (dark brown)	R
LOCUSTIDÆ—*Microcentrum* sp. (green)	R
GRYLLIDÆ—*Gryllus* sp. (dark brown)	A 3
COLEOPTERA:	
CARABIDÆ—*Carabidæ* (undet.)	A
Harpalus pennsylvanicus (black)	A
Scarites subterraneus (black)	R
COCCINELLIDÆ—*Coccinella* sp. (warning colors)	R 2
Hippodamia sp. (warning colors)	R
Adalia sp. (warning colors)	D
Epilachna borealis (yellow and black)	A
DERMESTIDÆ—*Dermestes* sp. (nearly black above, white below)	A
LAMPYRIDÆ—*Chauliognathus* sp. (warning colors)	R
SCARABÆIDÆ—*Ligyrus* sp. (reddish-brown)	R 2
Lachnosterna sp. (reddish-brown)	R 2
CHRYSOMELIDÆ—*Leptinotarsa decemlineata* (yellow and black)	R 2
Diabrotica sp	A
HETEROPTERA (all strong smelling):	
PENTATOMIDÆ—*Brochymena* sp	R
Nezara hilaris (green)	R
REDUVIIDÆ—*Arilus cristatus* (red-brown, wings with bronzed tips)	R

LEPIDOPTERA:

ARCTIIDÆ—*Hyphantria cunea* l. (yellow, brown, and black, very hairy) ... A 2 R 2

LIPARIDÆ—*Orgyia leucostigma* l. (red, black, white, and yellow, hairy, tufted) ... R 2

DIPTERA:

MUSCIDÆ—*Calliphora erythrocephala* (metallic blue) ... D

Sceloporus floridanus and *S. undulatus* are very close relatives; hence so far as the lizards are concerned, comparsions between the two sets of experiments are not far-fetched. Unfortunately, the insects offered have nothing more than the genus in common, and that in only a few cases. However, the comparisons possible on this basis are given:

	Pritchett.	Judd.
Brochymena	D	R
Chauliognathus	A 24 R 2	R
Harpalus	A 3 D 4	A
Gryllus	A 5+	A 3

Summing up Judd's experiments, we have the following results:

	A.	R.	D.
"Protected" group[39]	4	10	1
"Non-protected" group	8	10	1

Evidently these *Sceloporus* were hard to please, accepting barely more than a third of all the insects offered; 66 per cent. of the individuals of "protected" species were refused and 52 per cent. of the "non-protected" group.

Dr. S. Lockwood briefly records[40] the food habits of the Florida chameleon (*Anolis principalis*) in captivity. The lizards ate flies and spiders, but would not take the potato beetle (*Leptinotarsa decemlineata*), and, in fact, were not fond of beetles at all. Dr. Lockwood cites an observation by Bell, that a pet *Anolis*, catching an *Epeira diadema* by the leg, was bitten by its captive and death soon ensued.

MAMMALS.

Finn records[41] brief experiments with an East African mongoose (*Crossarchus fasciatus*). This animal refused one specimen of a frog (*Xenopus lævis*) and ate and vomited another. It ate and

[39] That is those "warningly" colored or otherwise "specially defended."
[40] *Am. Nat.*, 10, 1876, pp. 7, 8.
[41] *Natural Science*, I, No. 10, December, 1892, pp. 746–747.

vomited parts of a lizard (*Mabuia striata*), but the lizard was nevertheless entirely eaten. The mongoose was unwilling to eat birds and refused to attack a conspicuous milliped (*Spirobolus*). An obscurely colored milliped also was refused by a lemur (*Galago*).

Another of Finn's experiments concerning the tastes of mammals for insects deals with a tree-shrew (*Tupaia ferruginea*).[42] The conclusion is: "It is obvious that this animal had a very strong objection to the 'protected' Danainæ and *Papilio aristolochiæ*, as it so constantly refused them" (p. 532). This is a fair summary of the experiment except as it applies to *Papilio aristolochiæ*, the record for which was A 2 R 2.

Marshall and Poulton have published[43] accounts of experiments with a mongoose (*Herpestes galera*), baboons, and a monkey (*Cercopithecus pygerythrus*). The mongoose tested by Marshall (pp. 376–378) refused but one insect consistently and had only two trials with that. The animal was tested with birds as food and refused five out of ten kinds offered. Two of the five refused have colors of the type called warning and this is peg enough upon which to hang some speculations as to distastefulness. Nothing is said about the equally conspicuous colors of two of the species eaten, viz., *Nettopus auritus*, blackish-green, white and rufous; and *Saxicola pileata*, chestnut, black, and white. The results of single trials of several insects with *Cercopithecus pygerythrus* are recorded on p. 379, and pp. 380–392 are devoted to an account and discussion of more extended experiments with baboons. Poulton tabulates the Coleoptera accepted and rejected by the baboons, and from these tabulations it appears that about 75 per cent. of the beetles rejected had warning color patterns, as did about 55 per cent. of those accepted. It is unfortunate that there are no records of the natural food of these African mammals that can be used as a check on the experimental results.

MIXED GROUPS OF ANIMALS.

Brief notes on experiments with a marmoset and lizards are included in E. B. Poulton's description of the "means of defence adopted by the larva of *Stauropus fagi*" and the "defensive value of 'tussocks' of *Orgyia* and the associated black intersegmental markings."[44]

[42] *Journ. Asiatic Soc. Bengal*, 66, 1897 (1898), pp. 528–532.
[43] *Trans. Ent. Soc. Lond.*, 1902; pp. 376–392.
[44] *Trans. Ent. Soc. Lond.*, 1888, pp. 581–588 and 589–591.

We are told that when at rest the larva of *Stauropus fagi* resembles a withered beech leaf. Next, it is stated that the second and third pairs of thoracic legs are so held that they resemble, "in the most beautiful manner, a bunch of brown scales (the stipules of the foliage leaves) which enclose the buds of the beech, and hang down after the latter are unfolded." As if withered beech leaves, thus adorned, were common during the life of this larva and as if beech were the only food plant of the larvæ. As a matter of fact, *Stauropus* feeds on the foliage of several other woody plants. When aroused the larva is said by Poulton to assume a terrifying attitude, the main suggestion of which is a spider-like creature.

It is rather amusing to contemplate the variety of resemblances claimed for *Stauropus* larvæ. For instance, Poulton himself, ten years later, insists upon an entirely different resemblance from those above mentioned. He then says:

"The young larvæ of *Stauropus fagi* have often been described as resembling ants. The likeness has recently been analyzed in much detail by Portschinski (*Coloration marquante et Taches ocellées*, V, St. Petersburg, 1897, p. 44). This acute observer considers that the head of the larva represents the globular abdomen of the ant, while the head and antennæ of the latter are suggested by the larval caudal shield with its two appendages. He believes the disturbed larva represents an ant which has seized and is endeavoring to carry off some object on the branch which it is exploring. . . . . During the present summer (of 1898) I have had the opportunity of studying these larvæ. The young larvæ were thought to be ants by all the friends to whom they were shown. One lady considered that they were 'double ants'—an interpretation evidently due to their disproportionate length and to the head-like appearance of the caudal shield."[45]

Birchall[46] states that the young larva closely resembles a twig of beech with unopened buds, and that when feeding its likeness to a great earwig or to a *Staphylinus* is very striking. He also remarks upon the general suggestion of a crustacean in the larva's aspect, but he further desires "to speak doubtfully of the sharp eyes of a bird or *Ichneumon* being deceived when engaged in its own special business, by any such colorable imitation" (p. 233).

Mrs. Bazett[47] notes the great resemblance that the newly hatched

[45] *Journ. Linn. Soc. Lond., Zoology*, Vol. XXVI, 1898, pp. 589, 590.
[46] *Ent. Monthly Mag.*, XIII, 1877, p. 231.
[47] *Ent. Rec.*, II, 1891, p. 210.

larva bears to an ant, while Kirby[48] says it is from the extraordinary appearance of the larva that the species derives its name of lobster moth.

Thus the larva of *Stauropus* is supposed to mimic more or less closely, objects in both the vegetable and the animal kingdoms, and within the limits of the latter, representatives of five orders (not to mention ants carrying prey nor double ants), belonging to no fewer than three classes of the phylum Arthropoda. It is evident that the predaceous foes of *Stauropus*, had they only the imaginative powers of its human observers, could have a banquet of many diverse courses, each of which would be merely *Stauropus* in disguise.

Poulton says: "I should not, however, have ventured to speak so plainly of the meaning of the various details in the defensive attitude of the larva if I had not been able to rely upon the best support attainable—the support yielded by direct experiment."[49] He would have been approximately correct if he had said the poorest support attainable, but let us see what the support is. A marmoset and a lizard were offered one *Stauropus* larva each; they showed caution in attack, but *each ate the larva*. Rather a slender basis, one would say, for four pages of argument on the special defence of the creature.

The continuation of the argument—defence against insect enemies —is even more far-fetched. When irritated the larva displays black patches on certain segments, and Poulton thinks "it is clear that the black marks exposed by the larva are calculated to suggest to the approaching enemy [parasite] that the individual [larva] in question is already occupied." Super-parasitism is too common an occurrence to warrant the belief that parasitic insects are warned away by any visible signs of preoccupation.

The tussock moths (*Orgyia antiqua* and *O. pudibunda*) are supposed to be protected by the fine hairs of the tussocks which come out easily in immense numbers. Poulton says: "This interpretation is *entirely* due to experiment. A larva of *O. antiqua* was introduced into a lizard's cage and, when attacked, instantly assumed the defensive attitude. An unwary lizard seized the apparently feasible part of the larva: most of the tussock came out in its mouth, and the lizard seemed greatly troubled by the fine hairs and did not touch the larva again" (p. 590). An *Orgyia pudibunda* larva was killed but not eaten by another lizard.

[48] *The Butterflies and Moths of Europe*, 1903, p. 46.
[49] *Trans. Ent. Soc. Lond.*, 1888, p. 585.

The results of most of the earlier experiments with various animals are brought together by Prof. E. B. Poulton in a paper entitled, "The Experimental Proof of the Protective Value of Color and Markings in Insects with Reference to their Vertebrate Enemies" (*Proc. Zool. Soc. Lond.*, 1887, pp. 191–274). It is convenient to review these experiments collectively. Those covered by Poulton are as follows:

Butler, A. G. Remarks upon certain Caterpillars, etc., which are Unpalatable to their Enemies. *Trans. Ent. Soc. Lond.*, 1869, pp. 27–29.

Animals experimented with were *Lacerta viridis*, frogs, and spiders. In part previously published in *Ent. Monthly Mag.*, 5, 1868, pp. 131, 132.

Poulton, E. B. Diary of observations during 1886. *P. Z. S. Lond.*, 1887, pp. 269–274.

Using *Lacerta muralis*, *L. viridis*, and *Hyla arborea*. The earlier sketch of some of the results of these experiments is: "Some experiments upon the protection of insects from their enemies by means of an unpleasant taste or smell." *Rep. British A. A. S.*, 1886 (1887), pp. 694, 695.

Weir, J. Jenner. On Insects and Insectivorous Birds, and especially on the relation between the Color and the Edibility of Lepidoptera and their Larvæ. *Trans. Ent. Soc. Lond.*, 1869, pp. 21–26.

The birds used were seven species of finches, one weaver bird, one muscicapid, one pipit, and one thrush. Few of them are highly insectivorous species.

Weir, J. J. Further Observations on the relation between Color and the Edibility of Lepidoptera and their Larvæ. *Trans. Ent. Soc. Lond.*, 1870, pp. 337–339.

Birds used as in his previous experiments.

Weir, J. J. Diary of observations during 1886. *Proc. Zool. Soc. Lond.*, 1887, pp. 268, 269.

Experiments with lizards: *Lacerta viridis*, *L. agilis*, and *Zootoca vivipara*.

Weismann, A. *Studies in the Theory of Descent.* London, 1882, Vol. I, pp. 328–341.

Principally experiments with *Lacerta viridis.*

The main burden of the first half of Poulton's paper is the searching of the results of these experiments for support of "Wallace's original suggestion 'that brilliant or conspicuous larvæ would be found to be refused by their enemies'" (p. 196). In the preliminary sketch[50]

[50] *Rep. British A. A. S.*, 1886 (1887), p. 694.

of his own experiments Poulton says: "Wallace had predicted that brilliantly colored and conspicuous insects would be refused by the ordinary vertebrate enemies of their class." This statement, which was a "bull" from the very beginning (inasmuch as we cannot reckon as enemies of an insect those animals that refuse to eat it) is wrongly stated by Poulton in both of the above cases. Wallace's original suggestion, as reported in *Proc. Ent. Soc. London*, 1867, p. lxxxi, is that, "as a rule, the brilliantly colored larvæ were those which were distasteful to *birds*." Poulton further twists this in his table headings to a suggestion "that brilliant and conspicuous larvæ would be refused by some at least of their enemies," a much later modification of Wallace's statement.

However, this later claim would be admitted without argument did we accept Poulton's usage of the term enemies as including practically all insectivorous animals. Even if there were no other factors involved, the relative sizes of the larvæ and of various insectivorous animals in themselves establish limits to the number of predators upon a certain form; thus numerous large larvæ will be free from attacks of all but a small proportion of insectivorous foes. Very small larvæ, on the other hand, will be overlooked by many predators. That is, considerations entirely aside from coloration will limit the number of enemies of any given form. It is evident that all vertebrates cannot be enemies of the same insect; enemies and prey form indefinite groups that intermesh in a multitude of combinations. Consequently, an insect cannot be said to be protected, because certain vertebrates more or less ignore it, when they perhaps have no opportunity and certainly in many cases no necessity for feeding on it in the wild state.

Poulton first tabulates the results of experiments with eighteen species of "undoubtedly conspicuous larvæ," and concludes: "The first and obvious result of the first table is, with only one entirely antagonistic exception, the most complete demonstration of the truth of Wallace's suggestion that a highly conspicuous appearance would be found to be accompanied by some unpleasant attribute" (p. 205). Upon close inspection of this table, we find there are two, not one, species that are not shown to be distasteful to any animal, namely, *Deilephila euphorbiæ* and *Lasiocampa pini;* eight not refused by anything are included because they were disregarded by birds. The writer has explained above why disregard cannot be accepted as a test at all. The inadvisability of so doing is shown by the fact that at least three of these eight species of larvæ, namely, *Orgyia*

antiqua, *Cucullia verbasci*,[51] and *Hybernia defoliaria*, are known to be eaten by British wild birds. The other eight species included in the table comprise three others disregarded by caged birds, two of which are also eaten by British wild birds. These eight, however, were used chiefly in experiments with lizards, and four of them were accepted as well as refused upon trial. Of the four only refused, one (*Porthesia auriflua*) was eaten by hungry lizards in Poulton's experiments of 1887.[52] Another, *Pieris brassicæ*, was eaten more often than refused in Pocock's experiments (reviewed later), and a third which was rejected by frogs and lizards is known to be eaten by nestlings of *Parus major*.

Exception may be taken to remarks about some of the species listed in this table. For instance, *Deilephila euphorbiæ* was eaten by a captive lizard, and Newman says, "sea-gulls and terns devour them in numbers." We may add to the list of enemies the maüsebussard, on the authority of Schuster.[53] Poulton's comment on this larvæ is: "The correlation of a startling appearance with some unpleasant attribute must probably have existed once if not now. Have we a case in which hunger or opportunity have caused the enemies to neglect the latter and therefore to benefit by the former?" (p. 199). We cannot so conclude, unless we admit also that similar warning coloration (*D. euphorbiæ* is "black, red, and yellow or white") would lose its meaning (admitting for the purposes of argument that it has a meaning) to the same enemies in all other cases.

It is of interest to note that *Hybernia defoliaria*, included in this table because disregarded by captive birds, was found in the stomachs of three species of British birds by Robert Newstead.[54] Schuster (*l. c.*) records many species of birds as enemies of this larva as well as of *H. brumata*.

Table II includes four larvæ which only become conspicuous when approached and detected; one is not shown to be unpalatable to anything, one was both eaten and refused by lizards, and another was eaten by at least two species of birds and avoided without trial by two or more other species. The fourth species was refused by lizards and poultry, but eaten by nestling great tits.

One of the larvæ listed in this table has been made the basis of some

[51] See particularly the note, "Do birds eat the larvæ of Cucullia?" by H. D'Orville, *Entomologists' Monthly Mag.*, VI, June, 1869, p. 16.

[52] *Rep. British A. A. S.*, 1887 (1888), p. 764.

[53] *Ent. Bl.* Nürnberg, 5, Nr. 7, July 15, 1909.

[54] *Suppl. Jour. Bd. Agr. Lond.*, XV, No. 9, December, 1908.

of the most far-fetched theorizing imaginable. *Chærocampa elpenor* is its name; "When approached the anterior part of the body is distended and resembles a serpent-like head (of the cobra type)" (p. 206). In Weismann's experiments, "A tame jay ate the larva at once; sparrows and chaffinches (wild) were frightened by it, and would not come near a seed trough in which it was placed; fowls were evidently frightened, but in the end cautiously attacked it, when it was soon eaten." Lady Verney notes that small birds "would not come near a tray with crumbs on it on which the larva had been placed" (p. 206). The larva of *Chærocampa* is a large one (the ocellated spots are present only in last stage; if so useful, why is this the case?) and its size alone is sufficient to explain the actions of the small birds. In the case of the sparrows at least, almost any strange object of the same size might cause the same reaction. Anything new about their regular haunts is viewed with suspicion.

In regard to the Cobra-like appearance of *Chærocampa*, Poulton says: "It is likely that the terrifying appearance of our own larvæ probably first arose in the tropics, where the imitated cause of alarm to the enemies of the larvæ is real and obvious. And it is probable that the success of the same method in countries where the reptilian fauna cannot be said to constitute a source of alarm is due to the inherited memories of a tropical life which live on, as that instinctive fear of anything snake-like which is so commonly exhibited by the higher land vertebrates, including ourselves" (p. 204).

What a characteristic piece of selectionist reasoning(?); at least four very debatable biological propositions, namely, the tropical origin of the European fauna, its origin in a part of the tropics having cobras, and instinctive fear in man and other vertebrates, are practically taken as established facts. Aside from these assumptions, the argument is very amusing also when contrasted with that insisted upon by selectionists, in a hundred places, that birds have no instinctive knowledge of what is suitable for food, but must learn by experience. If an instinct of cobra fear is present in birds whose remote ancestors may possibly have seen cobras, it would seem that instinct about such an every-day matter as food were not a point to strain at. However, it is obvious that both arguments cannot well be supported by any but the exceedingly versatile.

Table III includes seven "not inconspicuous larvæ which are not nocturnal and which do not conceal themselves." Two are not shown to be unpalatable to anything and four are included on the basis of disregard by birds or lizards, at least two of which are eaten

by wild birds. While the remaining one was refused by three species of birds and disregarded by others, it also is eaten by wild birds.

Table IV presents the results for "bright-colored or conspicuous insects other than larvæ." It deals with fifteen forms, four of which are not shown to be distasteful to any animal; two are included on the basis of disregard only, and four were accepted and refused by the same class of enemies. One of the remaining five, *i.e.*, *Anthrocera filipendula*, imago, refused by lizards in these experiments, was eaten by lizards in the 1887 experiments (*l.c.*). Concerning another insect of this group, namely, *Abraxas grossulariata*, Poulton notes (p. 220) his opinion that Butler's record of frogs eating the moth must be a mistake. It is noteworthy, however, that he uses others of Butler's records without question. Butler later affirmed the correctness of his note, and showed that the same insect is taken by some birds.

Tables I–IV deal with forty-four insects, nine, or 17 per cent., of which are not shown to be distasteful to any animal; another nine were both accepted and rejected by the same class of enemies. Eighteen were either disregarded or rejected by birds, and at least nine of these are known to be eaten by wild British birds. We have pointed out above inconsistencies of some of the other cases with other experiments. In fact, as may be seen on p. 313, in seven out of eight possible direct comparisons of these experiments with those of Pocock, the only other extensive series using British insects, the results are inconsistent.

Eight of the insects of the distasteful groups in these tabulations were fed to hungry lizards, in experiments performed by Poulton in 1887,[55] and all were accepted. The behavior of the lizards in the cases reported contrasts strongly with that shown in the previous experiments as shown in the following table of comparisons.

	1886.	1887.
BIRDS:		
Orgyia antiqua, larva	D	A
Vanessa urticæ, pupa	R	A
LIZARDS:		
Euchelia jacobæ, l.	A 2 R 4 D	A
Pygæra bucephala, l.	A 3 R 3 D	A
Porthesia auriflua, l.	R 2	A
Anthrocera filipendula, ad.	R	A
Abraxas grossulariata, l.	A 1 R 7 D 2	A

[55] "Further Experiments upon the Protective Value of Color and Markings in Insects," *Rep. British A. A. S.*, 1887 (1888), pp. 763–765. These experiments, dealing with frogs, lizards, and a marmoset, and including a few of A. G. Butler's notes on birds, are not reported in full. Hence they are not reviewed.

FROGS:

Crœsus septentrionalis, 1	A	A

Thus it appears that these experiments are inconsistent among themselves, and from the fact that at least fifteen of the forty-four insects alleged to have been proved distasteful by the experiments are known to be eaten by wild British birds, we are justified in suspecting that the experimental results do not accurately indicate behavior under natural conditions.

A fifth table by Poulton comprises the results of experiments with insects which are protectively colored or which evade their enemies by other means. On the theory, therefore, all of these insects should be eaten freely by insectivorous animals. However, in sixteen out of sixty-eight cases, more than 23 per cent.,[56] the "evidences of distaste" are fully as strong as in the majority of the cases in the first four tables. Taking this fact in connection with that previously adduced, to the effect that 17 per cent. of the "protected" insects were not shown to be "unpalatable" to anything, and the additional fact that sixteen out of the forty-four, or 36 per cent., were included on the basis of disregard (some of them being eaten also), it is quite clear, that the insects, etc., were sorted out into the various tables, in accordance with the requirements of the theory, experimental evidence to the contrary notwithstanding. If authors are not consistent in the interpretation of the results of experiments, how can they expect others to have faith in them?

Poulton tries to explain the refusals of certain "protectively colored" imago Lepidoptera; for instance, with regard to *Vanessa urticœ* he says (p. 246): "I have no doubt that the refusal of some frogs was due to scales only," and of *Pieris brassicœ*, "eaten readily by all lizards, but not much relished, I believe, because of the mechanical difficulty of the scales and wings and not from being actually unpalatable." We cannot accept these explanations (which no doubt are true) without asking that they be made to cover the refusals of *all* adult Lepidoptera (of proper size for the animal experimented with). This would affect four species of Table IV and seven in Table V. We find Poulton later regarding *P. brassicœ* as intrinsically unpalatable (*P. Z. S.*, 1911, pp. 864, 865).

The inconspicuous larvæ of *Mania typica* were tasted and rejected by *Lacerta muralis*, Poulton's comment is: "At first sight a most

[56] This does not take into account earthworms and fly larvæ, which were rejected as well as refused, although the fact is not stated in the table.

startling difficulty, yet it is evident from the behavior of the lizards that they fully expected the larva to be palatable, in itself a strong confirmation of the suggestion that nearly all such larvæ are palatable" (p. 243). This is another argument that cannot be accepted unless it is also applied to the rejections of *conspicuous* larvæ upon trial, and this latter evidence rather than disregard is all the experiments yield that is worth any consideration. In fact, if impartially applied, this argument would do away with the experimental evidence of the efficacy of warning colors in all cases in which the insects were tasted before refusal. In other words, it would be just as fair to presume that these conspicuous larvæ also were expected to be palatable, "in itself a strong confirmation of the suggestion that nearly all such larvæ are palatable."

The experiments performed by R. I. Pocock, Superintendent of the London Zoological Gardens, like those just reviewed, cover a variety of vertebrate orders. A far larger number of species both of predators and prey were used than in any other experiments yet recorded. The captive animals included twenty-six species of mammals, ninety-six of birds, and seven of lizards, of which only six birds and one lizard occur naturally in England. The insects used were, of course, chiefly native. Even if we believe that experimental results have any value as indicating natural behavior, we can only conclude that the conditions of these experiments invalidate the findings, for of what possible value can it be to know the likes and dislikes of exotic animals for British insects?

The account of these experiments is in *P. Z. S. Lond.*, 1911, pp. 809–864. Mr. Pocock thinks his experimental results have "an important bearing upon the criticism sometimes advanced against the theory of warning coloration and mimicry as applied to butterflies, namely, that birds under natural conditions are seldom seen to eat these insects. Hence it has been inferred that birds cannot be reckoned as serious enemies of butterflies. Whatever may be the explanation of the circumstance," Pocock says, "I am tolerably sure, from the behavior of the two classes of animals when pitted against one another that the inference drawn therefrom is erroneous. The insectivorous birds in our aviaries seemed to know at once what the butterflies were; they were on the alert the moment one was liberated and pursued it with determination and precision, following its every turn and twist, and either catching it upon the wing or pouncing upon it after settling. It is true that this predatory deftness may have been acquired in relation to the chase of insects

other than Lepidoptera; but unless the birds recognized butterflies in general—a group which cannot be mistaken for other insects—as part of their natural prey, it is difficult to understand their eager excitement at the sight of those I offered them" (p. 811).[57]

Before quoting further, let us look into this argument a little: it is characteristic of the selectionist style. He is very charitable in admitting that predatory deftness *may* have been acquired in chasing other insects than butterflies. A little reflection will convince anyone, be he ignorant or not concerning the important constitutents of bird food, that butterflies even if eaten, can furnish but a small percentage of bird food, namely, an amount proportional to their numbers among diurnal insects as a whole. Hence a correspondingly small amount of training in predatory deftness can possibly have been acquired from capturing them. Pocock finds it difficult to understand the eager excitement of the birds at the sight of Lepidoptera, unless they recognized them as such; this after telling us on the preceding page of "the exceeding keenness of the birds for the insects brought to them. This was no doubt due in a measure to our inability in the Gardens to feed the birds on living insects other than mealworms."

Caged canaries, sometimes become frantically excited when a grasshopper or other insect is held up to the bars of their cage—they may never have seen an insect in their life before, they only know there is something they want. Pocock's parenthetical expression concerning Lepidoptera—"a group which cannot be mistaken for other insects"—directly opposes many arguments by selectionists relative to the resemblances of Sesiidæ to Hymenoptera; but any argument to establish the present point without reference to its bearing on other phases of the theory is a long-standing rule among selectionists. Continuing his argument, Pocock says: "Again, unless the species of butterflies used for the experiments are, or were in the past, habitually preyed upon by birds,[57] whence comes the extraordinary skill the liberated specimens . . . . displayed in dodging the swoop of birds in midair? Having repeatedly seen the aim of the pursuing bird baffled by the evasive twist of the butterfly, I cannot doubt that the insect's behavior was prompted by the instinct to escape an habitual enemy of its species, of the same class, and with the same predatory methods" (p. 811).

[57] It is worth pointing out that the disciple is here arguing directly against one of the cardinal teachings of the master, as Poulton iterates and reiterates, "acceptance is not proof of palatability" (*Trans. Ent. Soc. Lond.*, 1902, pp. 436, 317, 348, and 389).

Suppose a different experiment were performed: let some muskrats (*Fiber*) be put into an aquarium with some sea-lions; would their efforts to escape indicate previous experience in evading enemies of the same class? Not at all, it would indicate merely adaptation to expert progression in the same medium. The relations of birds (in general) to bats and of birds (again in general) to dragonflies are instances illustrating the same fact, but which are due to no general predatory relation between the groups. The wonderful powers of flight of many of the Syrphidæ are strictly comparable to that of butterflies, as the adults feed only at flowers and have no need of expert flight for predatory purposes; also they do not need it so highly developed for defense, for rather a small proportion of birds are capable of catching insects so expert on the wing. The extreme rapidity and dexterity of flight of humming-birds has no possible relation to their prey, nor need it have been developed to its present perfection to evade species that might be inclined to prey upon hummers. When Mr. Pocock arrives at the true reason for the extraordinary powers of flight of humming-birds, he will undoubtedly be less insistent upon the predator-evasion theory as an explanation of the tortuous flight of butterflies.[58]

Pocock further says: "Those who hold on the negative evidence above stated, that birds are not to be reckoned as serious enemies of butterflies, must be called upon to supply some explanation other than that above proposed of the marked reactions between these two classes of animals when brought into contact with one another, and to show reason why what takes place in the aviary may not be regarded as indicative of similar occurrences in nature" (p. 812).

The pertinent retort to this statement is that it is the selectionists who first claimed and who still claim that birds are important enemies of butterflies, and it is up to them to produce real evidence in favor of their contention. So far they have brought forward little except results of experiments. Pocock's own results, namely, the consumption of large numbers of British insects by exotic animals, should have convinced him that what takes place in the aviary may not necessarily be regarded as indicative of similar occurrences in nature. The point may be further illustrated by the following. Suppose a

[58] It is a matter of common observation that butterflies constantly exercise their powers of flight by playing with other butterflies even of different species. They often dart at falling leaves, flying bits of paper, and even birds. The writer saw (March 27, 1912, Plummer's Id., Md.) a *Vanessa antiopa* dash at and come within a few inches of a phœbe (*Sayornis*), that had just perched after one of its customary quick sallies at insect prey. The bird, a highly insectivorous species, paid no attention to the butterfly.

man has fired his last shot ineffectually at a charging tiger or rhinoceros; he naturally shows a "marked reaction" by taking to his heels, not because he or his ancestors have had similar experiences, but because he can run. So with the butterflies, skilful efforts to escape do not necessarily indicate previous racial experience of the same nature.

The principal failing of the selectionists always has been a vast ignorance of what wild birds really eat. They have made very little effort to acquire such knowledge, and their speculations throughout show the lack of it. Practically the only large body of authentic information on the natural food habits of birds is contained in the records of the United States Biological Survey. They comprise detailed identifications of the contents of more than 48,000 bird stomachs representing all families of birds and collected in hundreds of localities in the United States at all seasons. The United States has a goodly representation of butterflies, yet only five of these 48,000 stomachs contained remains of Rhopalocera. It is hoped this will be more satisfactory to the selectionists than the "negative evidence" they are accustomed to cite with contempt.

The extreme artificiality of Pocock's experiments and the inapplicability of the results to the natural relations of British birds and insects are so evident that it is not worth while to comment on the details. A few comparisons of the results with those of experiments recorded by Poulton are of interest as showing the inconsistency, *inter se*, of experiments. It has not been possible to collect a large number of such comparisons because Poulton's experiments were chiefly with lizards and few with birds, while the opposite is true of Pocock's. The varying stages in which the insects were presented also tend to limit comparisons. The table includes all possible direct comparisons and only one pair in eight shows real correlation.

	Poulton.	Pocock.
BIRDS:		
Vanessa urticæ, larva	D	A 7 R 4 D 1
" " pupa	R	A 2 R 2 D 1
Clisiocampa neustria, larva	D	A 1
Euchelia jacobæ, ad	A	A 1 R 4
Cosmotricha potatoria, larva	D	A 1 R 4 D 1
Anthrocera filipendula, ad	A	R 4
LIZARDS:		
Apis mellifera, worker	A	R 3
Pieris rapæ, ad	A 20	A 2

Notes on Pocock's experiments, by Prof. E. B. Poulton, are given

on pp. 864–868, and show his customary facility in drawing conclusions satisfactory to himself from the most refractory evidence. For instance, he says: "The experiments on the *Pierinæ* support the conclusion that the perfection of the under surface procryptic resemblance affords a true criterion of the degree of palatability. *Pieris brassicæ*, with its conspicuous gregarious larva and imago larger and less cryptically colored than the other three species . . . . was distinctly the least palatable" (pp. 864, 865). The records of acceptances and rejections of the three species of *Pieris* are as follows: *Pieris rapæ*, A 10 R 2, a proportion of 5 to 1; *Pieris brassicæ*, A 40 R 33, 1⅛ to 1; and *Pieris napi*, A 8 R 8, 1 to 1; *P. napi* thus being the least favored in the experiments. These figures are reproduced not because the point as to relative palatability is of any importance, especially as an indication of natural preferences, but merely to show that the experimental results are not accurately judged by those most interested in them. It is of interest to compare Pocock's results with *Pieris brassicæ* with those obtained by Dr. G. Rörig in Germany. Pocock records the pupæ of this insect as A 1 R 8 D 3, and the adult as A 16 R 7 D 1, while Dr. Rörig says:[59] The pupæ of the Kohlweisling "were eagerly torn open by all the titmice," and the adults "were always freely eaten by all the birds which I have tested."

Poulton bases considerable speculation upon the unpalatability of *Araschnia levana*, the record for which in the experiments is A 20 R 10. He follows this with a page of theorizing on the probable mimicry of *Melitæa* by *Hesperia*, and says that the experimental "results as a whole leave little doubt that *Melitæa* is distasteful to many birds, and that it does actually possess the qualtities which would render it an advantageous model for the Hesperiidæ" (p. 867). As a matter of fact, the experiments with birds and *Melitæa* described on pp. 826 and 827 show that it was finally refused by only one bird; it was eaten by thirteen species, seven species of which took nine specimens without hesitation. Two birds which dropped the first specimen offered them later took one and two, respectively, including those dropped. The final record for birds is A 18 R 1. If this is considered proof that *Melitæa* is advantageous as a model, the demands of the theory are most modest.

On p. 867 he also refers to *Melanargia* as a highly distasteful genus; its record in the experiments is A 14 R 4. Another extract from

[59] *Arb. Biol. Abt. f. Land. Forstwirts. K. Gesundheitsamte*, 4, 1903, p. 47.

Poulton's remarks is, "Although so many insectivorous animals in confinement disregarded the special defence of *Formica rufa*, there can be little doubt that such defence is very effective in the wild state. It is impossible on any other hypothesis to account for the conditions under which the species exists, swarming in vast numbers in restricted areas and an easy prey to any enemy that would dare to attack" (p. 868). Here we have a case where experimental results are not in accord with the theory, and it is evident that it is so much the worse for the experiments. Where the evidence is of a supporting nature, experiments are extolled to the skies. Pocock, who tries to stick consistently to the experimental results which for *Formica rufa* were an indefinite number of acceptances and no rejections by a monkey, A 13 R 0 by birds, and two refusals by lizards, says: "The unavoidable conclusion that these insects are palatable is rather surprising in view of the frequency with which ants are mimicked in the tropics" (p. 849). In deeming it impossible for the ants to live as at present unless specially defended, Poulton takes the struggle for existence too seriously. In fact, he seems to think all gregarious insects must be specially protected, thus overlooking periodical cicadas, migratory locusts, canker-worms, army-worms, etc., which usually occur in large numbers and are eagerly attacked by a great variety of insectivorous foes.

Poulton further remarks: "It was also apparent in many of the experiments that the unpalatability of conspicuous Lepidoptera was . . . . far more obvious to the birds than the mammals. In view of the part which birds are believed to play in the production of mimetic resemblances, it is obvious that this inference may be highly significant" (p. 868). The writer has tabulated the acceptances and rejections for mammals and birds, including only those Lepidoptera which were refused by some species, and the result is mammals A 19 R 10, or about 34 per cent. refused, and birds A 112 R 80, or about 41 per cent. refused. Hardly enough difference to warrant the comment quoted.

A very interesting series of experiments with frogs, lizards, birds, and mammals upon a good variety of insects and other invertebrates as subjects were performed by Beddard and Finn at the London Zoological Gardens and recorded by the former in his volume entitled *Animal Coloration* (1892, pp. 149-166). Mr. Beddard's principal conclusions are as follows: "It is quite clear from these experiments that insects which exhibit warning colors are by no means always exempt from attack. The opinions of insect-eating

mammals, birds, and reptiles appear to vary as to the edibility of this or that insect. . . . . But these experiments do show that very generally, though not always, a disagreeable taste is associated with a conspicuous and varied coloration. On the other hand, precisely the same deductions can be drawn by watching the behavior of animals when offered inconspicuously colored insects" (p. 155).

As in previous cases, we will give the direct comparisons that can be made between these and other sets of experiments. Four out of seven contrasted pairs are contradictory.

	Poulton's Tables, 1887.	Beddard.	Animals tested.
Armadillo vulgaris	A	A 2	*Lacerta viridis.*
Lithobius forficatus	A	R	" "
Pieris brassicæ, l.	R	A 5 R 2 D 1	Lizards.
Abraxas grossulariata, l.	A 1 R 7 D 2	R 1 D 2	"
Vespa vulgaris	D	A 2	"
Euchelia jacobæ, l.	A 2 R 4	A 1 R 3 D 1	"
	Pocock, 1911.	Beddard.	
Pieris brassicæ, l.	A 20 R 18	A 2 D 1	Birds.

Beddard justly remarks (p. 166): "None of these experiments are thoroughly satisfactory; it is so difficult to interpret them, and they are often contradictory, for a bird will eat one day what it has refused before. The experiments that have been made are like most other statistics—they may be made to prove anything. A careful series of observations upon the contents of the stomachs of wild birds would be the nearest approach to a satisfactory solution of the difficulty; but there are obvious objections to this mode of investigation."

Fortunately, this objectionable method has been pursued to some extent in England, *i.e.*, by Newstead, and to a slight degree the work serves as a check on experiments with British birds and insects. Beddard gave an earwig to a green woodpecker, which made a great deal of fuss over it, but ended by swallowing it; Newstead found these insects in two stomachs of green woodpeckers, one of which contained 23.[60]

Merely for the sake of completeness the very brief notes upon experiments by Thomas Belt[61] may be given here:

A tame white-faced monkey always killed but did not eat Heliconii (pp. 316, 317).

[60] *Suppl. Journ. Bd. Agr.* [*Lond.*], XV, 1908, p. 64.
[61] *The Naturalist in Nicaragua*, 1888.

Lampyridæ were "invariably rejected by the monkey, and my fowls would not touch them") p. 317).

A red and blue frog was not touched by fowls and ducks, but one of the latter tricked into taking one rejected it (p. 321).

We may add also those of Haase:[62]

Erithacus rubecula had to be starved into eating *Zygæna trifolii* (p. 20).

Fowls always rejected *Danais chrysippus*, but eagerly ate *Papilio pammon*. Captive monkeys also rejected *Danais* (p. 23).

Attempts to feed species of *Danais*, *Pharmacophagus*, *Delias*, and *Euschema* to tame chickens were unsuccessful (p. 99).

Danais septentrionalis was rejected by caged lizards (*Calotes mystaceus*) (p. 99).

The following, appended in bibliographic form, are self-explanatory:

DONISTHORPE, H. ST. J. K. Cases of Protective Resemblance, Mimicry, etc., in the British Coleoptera. *Trans. Ent. Soc. Lond.*, 1901.

Three species of lizards were found to reject the Telephorid, *Psilothrix nobilis* (p. 362).

Specimens of *Melasoma populi* "were pecked at, but finally refused, though killed, by Shama, Pied Mynah, Laughing Jackass and Brambling. The Drongo and *Graculipica nigrirostris* ate several." The author says: "It appears to me that their refusal by so many insect-eaters *in confinement* conclusively proves their distastefulness" (p. 368). It proves nothing of the sort. Moreover, "distastefulness" of the kind here claimed seems to be no protection at all. Specimens of *Cassida equestris* were eaten by all the birds to which they were offered (p. 369).

SHELFORD, R. Observations on some Mimetic Insects and Spiders from Borneo. *Proc. Zool. Soc. Lond.*, 1902, pp. 230–284, pls. 19–23.

Two tame monkeys (*Macacus cynomolgus*) manifested disgust after tasting specimens of the Reduviid (*Eulyes amœna*), but ate its mimic, the mantis (*Hymenopus bicornis*) (p. 232). The writer says he has proved the distastefulness of Lycidæ, by repeated trials with various small mammals and birds (p. 244). "All the Lycidæ are strongly distasteful . . . . A strong vitality is correlated with this distastefulness: I have seen a Lycid beetle walk away apparently uninjured after it had been well pecked by two or three fowls" (p. 267).

TITCHENER, E. B., and F. FINN. Comparative Palatability of Insects, etc. *Nature*, Vol. 42, No. 1,093, October 9, 1890, pp. 571, 572.

[62] Haase, E., *Researches on Mimicry*, Part II, Stuttgart, 1896.

The animals used in these experiments were domestic mice, toads, a mynah (*Acridotheres tristis*), a heron (*Ardea cinerea*), a prairie owl, a water tortoise and a lizard. The results of the experiments are described in detail, but no general conclusion is given. At least seven of the things offered as food were both accepted and refused by the same species of animal. This number included the common earthworm (*Lumbricus terrestris*).

TITCHENER, E. B. Comparative Palatability. *Nature,* Vol. 44, No. 23, October 8, 1891, p. 540.

Experiments with frogs, toads and ducks, supplementary to the above; no general remarks.

TITCHENER, E. B. Comparative Palatability. *Nature,* Vol. 45, No. 3, November 19, 1891, p. 53.

These experiments relate to the choice of food by captive goldfish, silverfish, frogs, and a spider. The details are given without comment.

BIRDS.

Experiments in Europe.

Birds have been used more frequently than animals of any other class to test the potency of the protective adaptations of insects and other groups under experimental conditions. One of the most important series of experiments was carried on chiefly as a study of the origin of the process by which food is accepted or rejected by birds. In this series Prof. C. Lloyd Morgan performed various experiments with young chicks, pheasants, guinea-fowls, moorhens, and ducks, the net result of which "is that, in the absence of parental guidance, the young birds have to learn for themselves what is good to eat and what is distasteful, and have no instinctive aversions."[63] The results of these experiments are often quoted by the selectionists, and as usual in such cases with sweeping inclusions not at all intended by the author. He says: "I am not, of course, prepared to say that in no case is there such instinctive aversion. . . . . Birds like the megapodes, which are hatched out in mounds apart from parental influence . . . . may show instinctive avoidances which our well-cared-for birds do not possess. That the parent bird does in most cases afford guidance is unquestionable" (pp. 43–44).

Some of the principal results that have a bearing on the value of warning colors under experimental conditions are as follows:

1. Chicks tested and rejected cinnabar caterpillars (*Euchelia jacobæ*), but ate brown loopers and larvæ of the green cabbage-moth (p. 42). A jay ate five cinnabar larvæ, but would take no more (p. 43).

[63] *Habit and Instinct,* 1896, p. 43.

2. Young moorhens found the conspicuously colored burnet moths (*Zygæna filipendula*) distasteful, the obnoxious part being the wings, for the body from which the wings were removed was eaten with apparent relish while the severed wings were rejected (p. 42).
3. *Lumbricus fœtidus* was refused at first, as were all other earthworms for some time afterwards. Later all were eaten.
4. All birds tested avoided woolly-bear caterpillars (*Arctia caja*).
5. Jays, ducks, and moorhens ate caterpillars of the tiger moths, *Nemeophila plantaginus* and *Chelonia villica*, while chicks, pheasants, and guinea-fowls found them distasteful (p. 43).
6. Jays ate pupæ of *Abraxas grossulariata* (p. 43), an insect refused by most of the captive animals to which it has been offered.
7. One jay ate a larva of *Phalera bucephala*, which another jay and duckling and chicks refused (p. 43).
8. Soldier-beetles and ladybirds were avoided (p. 43).

In No. 2, intrinsic distastefulness is not shown; it is the dry, scaly wings that are objectionable. Nos. 3, 5, and 7 give evidence for both sides of the question, and No. 6 is inconsistent with most other experiments on the same insect.

The evanescence of some associations concerning food are shown by the following experiment: Bits of orange peel were offered to a young chick that had learned to eat yolk of egg; they were refused, as were also bits of yolk substituted immediately afterward. Subsequently the yolk was again tested and accepted (p. 41).

Another test indicates that in some cases taste cannot be the criterion upon which choice is made. "While small worms are picked up with avidity, large worms are left alone by quite young birds and often evoke the alarm note. None of the chicks on the fifth day dared go near a particularly large worm. Bits of red-brown worsted, somewhat resembling worms, were seized with eagerness and eaten with surprising avidity so long as they were not more than a couple of inches long. Of a four-inch bit the chicks were afraid, until one bolder than the rest, seized it, whereupon the other chased him for the prize till he escaped to a secluded corner and swallowed it"(p. 50).

An unusual experience with customary food may lead to its rejection, as decisively as if it were "nauseous" and "warningly colored." "Pheasants and partridges, when they seized a worm for the first time, shook it and dashed it against the ground; one of them did so, indeed, with such vigor that he shook himself over, and thereafter could not for some time be induced so much as to look at a worm" (p. 51). "A little pheasant which would run to my hand for wasp

larvæ placed upon the palm, one morning gave the alarm note, and would not as usual jump upon my fingers. Four or five of the grubs had stuck together so as to form a large mass of which he was afraid!"

"Moorhen chicks were at first afraid of the common yellow underwing moth and of the gamma moth, though both were eaten freely after I had given them dead moths" (p. 50).

"Even protective coloration is of little value if there is movement, so sharp are the eyes of young birds. The caterpillar of the small white butterfly (*Pieris rapæ*) on a nasturtium leaf, with which its clear green color assimilated well, was picked off by a moorhen chick the moment it moved its head. Recently hatched stick insects (*Diapheromera femorata*), which Prof. Poulton gave me, were snapped off the lime leaves directly they moved" (p. 46).

Prof. Morgan made many tests with bees and wasps, and in summing them up says: "Much . . . . depends on the nature of initial experience. A bird that has in early days seized a bee with ill effects is shy for a long time, not only of bees, but of moths, large flies, and beetles, while one which is so stung at a later stage is made, perhaps, a little more cautious generally, but the main effect is a particularized one concerning bees or the bee-like drone fly" (p. 54).

A series of experiments, of much the same nature as Morgan's, but shorter, is described by L. W. Kline.[64] Chicks were tested with earthworms, white boring grubs, cabbage worms, and bits of yellow pine and starched muslin. "They rejected pine wood after a few experiences at the age of three days, but three days later they ate it again, while experience with muslin on the third day was lasting. They were six days getting acquainted with earthworms and eight days with canker [cabbage] worms" (p. 276).

An excellent article, previously referred to, "The Food of Some British Birds,"[65] by Robert Newstead, besides presenting the largest amount of detailed information on its subject, thus far brought forward, contains a short account of an experimental feeding of starlings. Certain food items were placed near a nest in which young were being fed. One centipede (*Geophilus longicornis*) and one earwig (*Forficula auricularia*) were refused, although each species had previously been given to the nestlings by the parent birds. Only

[64] "Methods in Animal Psychology" [Chicks], *Amer. Journ. of Psychol.*, *10*, 1898–9, pp. 265–277.

[65] *Suppl. Journ. Bd. Agr.* [*London*], XV, No. 9, December, 1908.

one of six wood lice (*Oniscus asellus*) was accepted, and from five to seven green cherries were refused. Both of these items are eaten by adult starlings, thus rounding out to a total the contradictory evidence as to choice of the four items by the same bird under natural and under artificial conditions.

In 1889 and 1890, Mr. A. G. Butler, whose experiments with lizards are included in the tables of Poulton, previously discussed, published three articles dealing with the food preferences of captive birds. These included both British and tropical birds, which were kept in large aviaries. The first[66] of Mr. Butler's trio of papers treats only the general results of six years' experimenting. He says: "My experience . . . . has been that no insect in any stage was ever refused by all the birds; what one bird refused another would eat" (p. 171). In the course of this paper, Mr. Butler casually remarked that for two years he had sent data on the experiments to Mr. Poulton, "not even retaining a copy of my notes, but so far nothing seems to have come of it; I presume, therefore, that my facts have rather tended to mystify than clear the matter up" (p. 171). Poulton seems to have taken deep umbrage at Butler's remarks, as he returned the notes and made a hot reply on pp. 358–360 of the same volume. Butler later published his notes in full,[67] and says: "Few things ever astonished me more than the hostile attitude which Mr. Poulton assumed with regard to that innocent paper, or the cruel misconstruction which he put upon the most harmless remarks made therein; that my comment touching the repeated reproduction of a few comparatively unimportant observations of my own should have been dislocated into a claim to the origination of Wallace's theory is too absurd to be considered seriously. . . . . I still insist that, so long as a few desultory observations are incessantly forced into a front place, it is an evidence of how little has hitherto been done upon which to establish the truth of a theory; many more observers are wanted, and all their observations must be *impartially* treated if we are to arrive at exact scientific truth. I was not aware that Mr. Poulton had made a selection of 'the most interesting results' of my recent experiments for publication in the Report of the British Association, or I should not have said 'so far nothing seems to have come of it'; nevertheless, as it is impossible for any

[66] "A few remarks respecting Insects supposed to be distasteful to Birds," *Annals and Mag. of Nat. Hist.*, Sixth Ser., Vol. IV, 1889, pp. 171–173.

[67] "Notes made during the summer of 1887 on the effect of offering various Insects, Larvæ, and Pupæ to Birds," *l.c.*, pp. 463–473.

one man to judge how far even apparently uninteresting results may eventually tell for or against a theory—as, too, Mr. Poulton has evidently forgotten some of those facts . . . . I think I cannot do better than publish the whole of my observations in detail" (pp. 463, 464).

"The most interesting results" made use of by Poulton[68] are remarks upon only four species of insects eaten by birds, while Butler's notes deal with at least forty-seven species of insects and other invertebrates. Moreover, without mentioning Butler's results, Poulton discusses the results of his own tests with lizards and a marmoset of three other species of insects, which Butler had fed to birds. Poulton gratuitously observes: "If I had no more notes than those supplied by Mr. Butler, their preparation for publication would be only a work of a few hours; but these notes are a very small fraction of the whole."[69] The fact remains, however, that the *large* "fraction of the whole," with unimportant exceptions remains unpublished to-day. As a result of this series of experiments, Butler concludes that "no insect in any stage, excepting the red-tailed bumble-bee (which, by the way, I only offered to the missel-thrush), was rejected by all my birds; those insects which were refused by certain species were eagerly devoured by others. . . . . In the second place, so far from my birds learning by experience to reject with scorn that which they had proved to be unpalatable, I found that in some instances they seemed to acquire a taste for larvæ previously refused. Birds are very intelligent, but their memories are ridiculously short" (p. 473).

Butler's third paper[70] enumerates tests of 17 invertebrates offered to birds, with the following principal conclusion: "My experiments have convinced me that the tastes of birds not only differ in individuals of the same species, but that the same individuals in consecutive years vary as to their likes and dislikes."

Unfortunately, the experiments of Butler cannot be compared with those of Pocock, who also used British insects and both native and exotic birds, as Butler does not record the number of times an insect was refused or accepted, but only tells what species of birds ate it and which did not. Probably the only coincidence of the same

[68] *Rep. British A. A. S.*, 1887 (1888), pp. 762, 763.
[69] *Ann. and Mag. Nat. Hist.*, 1889, pp. 359, 360.
[70] "Notes made during the present year on the Acceptance or Rejection of Insects by Birds," *Ann. and Mag. Nat. Hist.*, Sixth Ser., Vol. VI, 1890, pp. 324–327.

species of bird tested with the same stage of the same species of insect, in the two sets of experiments, is *Leiothrix* with larvæ of *Pieris brassicæ*. The result in each case was acceptance.

A. D. Bartlett recounts an experience in rearing young water ouzels which well illustrates the fundamental difference between experimental and natural conditions. He says:[71]

"They had been tried with the usual food for most insect-eating birds, such as scraped beef and hard-boiled eggs, ant eggs, mealworms, spiders, flies, beetles, aquatic snails, shrimps, salmon spawn, and many other mixtures, but all failed, until my clerk and assistant, Mr. Arthur Thomson, who had taken as much interest in rearing these birds as myself, hit upon the idea of scalding the mealworms, and tried it. It was soon apparent that in this condition the mealworms could be digested, while in a raw or living state they (especially their hard skins) would pass through the birds in a hard and undigested condition. From this moment I had but little trouble. The birds fed greedily upon the half-boiled mealworms, and I soon found them ready to leave the nest."

Thus these birds did not thrive upon a regimen that included several elements of their natural food, but did well only when the staple food was *partially cooked*. Mr. Bartlett adds:

"In May, 1869, I obtained my first living water ouzel. Since that time I have had a great many of these birds. Some of them I reared from the nest, and I fed them upon boiled mealworms, the larvæ of the caddis fly and other insect food; but as soon as they were able to feed themselves and took to the water, they caught and fed upon very small fish, especially young minnows. I found them rather expensive pets, having to provide for a family of four, as they caught and devoured several dozen daily, and seemed to prefer live fish to all other food."

If experimental results could be taken as a guide to natural behavior, we should conclude from this testimony that water ouzels feed laigely on fish. It is worthy of note, therefore, that Newstead[72] found no fish in the stomachs he examined.

In the account[73] of the experiments by Dr. G. Rörig, previously referred to, it is stated that all of the following insects:

[71] *Wild Animals in Captivity*, 1899, pp. 308–310.
[72] *Suppl. Journ. Bd. Agr. Lond.*, XV, No. 9, December, 1908, p. 25.
[73] *Arb. Biol. Abt. f. Land. u. Forstwirtschaft. K. Gesundheitsamte*, IV, 1903, Heft 1, pp. 34–50.

Cnethocampa pinivora, eggs and larvæ;
Fidonia piniaria, larvæ;
Euproctis chrysorrhœa, larvæ;
Clisiocampa neustria, pupæ and adults;
Liparis salicis, pupæ and adults;
Pieris brassicæ, pupæ and adults;
Porthetria dispar, adults;
Nematus abietum, larvæ;
Nematus salicis, larvæ,

were taken eagerly by captive birds, such as titmice, redstarts, kinglets, nuthatches, etc. Although the list includes hairy larvæ, some with urticating hairs, and sawfly larvæ which other experimenters state that birds usually reject, Dr. Rörig does not mention any refusals. We have already quoted his notes on the acceptance of *Pieris brassicæ*, which has been classed as distasteful. Dr. Rörig's birds also ate plant-lice, *Aradus cinnamomeus*, *Cecidomyia saliciperda*, *Retinia buoliana*, *R. turionana*, *Phyllopertha horticola*, and *Scolytidæ*.

We may note here also the experiment[74] of Dr. Günther in feeding Meloidæ to chickens. He fed the fowls from 1 to 5 grams of Cantharus daily, until a total of 28, 28, 40.5 and 80.5 g. of the material was taken by four chickens respectively. One of the birds which ate 28 g. showed symptoms of poisoning; the others remained healthy. Significant amounts of cantharidin were recovered from the bodies of these birds, and even from eggs laid by them.

Another German experiment but slightly related to the theory of protective adaptations is recorded[75] by Alexander Bau. The titmice, *Parus major* and *P. communis*, accepted in confinement eggs of *Liparis monacha*, *Porthetria dispar*, *Orgyia* spp., and *Clisiocampa neustria* (p. 69).

Brief mention should be made of the following:

[DONISTHORPE, H.] [Experiments with Birds.] *Proc. Ent. Soc. Lond.*, 1901, p. xiii.

Quoted by Rev. Canon Fowler, to the effect that *Clythra quadripunctata*, *Gonioctena rufipes*, and species of *Lina* were rejected by several species of British and foreign birds in the London Zoological Gardens. All of these beetles were eaten by a racket-tailed drongo.

LONGSTAFF, G. B. Experimental evidence as to the Palatability of Butterflies. *Trans. Ent. Soc. Lond.*, 1908, pp. 629–631.

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[74] *Tierärztliches Zentralbl.*, 34, Nr. 18, June 20, 1911, S. 273–276.

[75] "Nutzen und Schaden durch die Vögel; Vogelschutz." In *Naturgeschichte der Deutschen Vögel*, by C. G. Friderich, Stuttgart, 1905, pp. 60–76.

The experiments were performed in Ceylon with *Gracula* sp., and domestic fowls. "So far as these experiments teach anything, it would appear that these mainas would eat with relish *Nissanga patina*, *Yphthima ceylonica*, *Atella phalanta*, *Ergolis* sp., and *Lampides* sp. On the other hand, *Papilio aristolochiæ* and *Crastia asela* were distinctly distasteful. The evidence as to the other species experimented with fails to convince me one way or the other" (p. 631). In several of the experiments the birds apparently were not hungry enough to care for anything.

Experiments in Africa.

In their extensive and interesting paper on the "Bionomics of South African Insects,"[76] Marshall and Poulton record the results of experiments with kestrels (*Cerchneis rupicoloides* and *C. naumanni*) and a ground horn-bill (*Bucorax caffer*).

The experiments with the kestrels (pp. 340–345) are characterized by the average small number of trials of the various insects used. The writer desires to draw attention to only one point in the discussion of these experiments. On p. 346, Poulton says with regard to some supposedly distasteful beetles which the birds had eaten: "It is probable that most of the defensive fluid had been already discharged in the case of the Carabidæ of the genera *Piezia*, *Polyhirma*, and *Graphipterus*, of which the acid secretion was seen to be a very positive protection when there was opportunity for its operation on a normal scale." The "normal scale" referred to was the offering of the beetles *tail first!* Marshall found these carabids in the stomachs of certain wild birds, and in discussing this Poulton says the fact is not remarkable, as "the defensive secretions may be discharged and lost as the result of the attacks of an experienced enemy" (p. 353). This better illustrates action on a "normal scale."

The ground horn-bill experimented upon by Marshall (pp. 347-348) ate all butterflies offered it, including several of the reputed "protected" forms, with the exception of two specimens of *Limnas (Danais) chrysippus*. Poulton, therefore, remarks: "It has already been pointed out that the acceptance of insects by insectivorous animals in captivity is no proof of their normal likes or dislikes in a wild state. . . . . Hence the fact the Acræas were devoured is no evidence that they are normally eaten except in a time of unusual hunger" (p. 348). Marshall,[77] however, says: "The bird was

[76] *Trans. Ent. Soc. Lond.*, 1902, pp. 287–504.
[77] *Trans. Ent. Soc. Lond.*, 1908, p. 139.

entirely unconfined, and wandered at will searching for its food just like his wild relatives on the next hillside, with only this exception, if insects, etc., were scarce, the . . . . bird always got additional food at the house. The conditions of the experiment, therefore, render it highly improbable that the hornbill was eating insects which it would normally reject, and its whole demeanor was quite at variance with such a supposition."

It is apparent that experts may draw very different conclusions from the same experimental data, a fact among many which points to the conclusion that the results of stomach examination are the only reliable criteria regarding bird food.

Experiments in Asia.

No experiments are more widely quoted than those performed by Frank Finn while Deputy Superintendent of the Indian Museum, Calcutta. Only those of Pocock are more extensive, and they were performed under much more artificial conditions. The results of Finn's experiments on birds are published in the *Journal of the Asiatic Society of Bengal*, as follows:

No. I. Experiments with a Babbler (*Crateropus canorus*). Vol. 64, 1895 (1896), Pt. 2, pp. 344–356.

No. IV. Experiments with various Birds. Summary and conclusions. Vol. 66, 1897 (1898), Pt. II, pp. 613–668.

The birds used in these experiments were:

Pekin robin	*Leiothrix luteus.*
Common babbler	*Craterupus canorus.*
Red-whiskered bulbul	*Otocompsa emeria.*
Common bulbul	*Molpastes bengalensis.*
Yellow-vented bulbul	*Molpastes leucotis.*
White-crested bulbul	*Pycnonotus sinensis.*
Green bulbul	*Chloropsis* sp.
White-eye	*Zosterops* sp.
Sibia	*Malacias capistrata.*
Mesia	*Mesia argentauris.*
Button quail	*Turnix taigoor.*
Bhimraj	*Dissemurus paradiseus*
King-crow	*Dicrurus ater.*
Shama	*Kittacincla macroura.*
Indian starling	*Sturnus menzbieri.*
Mynah	*Acridotheres tristis.*
Black and white hornbill	*Anthracoceros* sp.

The *Zosterops*, probably because of their small size, played a very

minor part in the experiments, caged as they were with a variety of larger birds; the *Mesia* had an exceedingly brief trial, and the *Anthracoceros* was tested principally with dead and dry insects left over from experiments with other birds. Finn remarks that of two individuals of this last species, one did not care for insects at all, the other on some occasions had to be coerced into eating insects of the supposedly palatable kinds.

In commenting upon the significance of his experiments Finn puts an emphasis on order of choice between insects, which the writer does not consider justifiable. These as all other experiments are to determine what will be eaten, and the fact that insects not eaten in the presence of the experimenter, as a rule, were devoured before his next visit or the next morning, shows the futility of drawing fine distinctions as to apparent preferences.

More than 123 butterflies which were left in the cages were eaten in the absence of the experimenter or by birds not specified, and more than 77 per cent. of them belonged to the "nauseous" group. About seventy-two butterflies remained uneaten overnight, though it should be remarked that many of these were taken later the next day. Of the seventy-two, about 85 per cent. belonged to the "nauseous" group, a percentage practically no different than in the case of those eaten. It is worthy of note that the number of butterflies left uneaten is definitely stated in every case, while those eaten are often included in general terms, as "some," "several," etc. In making these calculations, "some" has been reckoned as two; undoubtedly it sometimes meant more. These expressions occur nineteen times for the "nauseous" group among the butterflies eaten in the absence of experimenter, only once for the "palatable" group, and not at all in the case of butterflies left over. Hence there is no doubt as implied above that the proportions of these groups are about the same in the butterflies eaten as in those left over.

In the following table are shown the approximate numbers of acceptances and rejections upon trial of both the "nauseous" and "palatable" groups of insects. Species of the former group used are *Acraea* [illegible], *Danaus chrysippus*, *D. genutia*, *D.* [illegible], *Delias eucharis*, *Euploea* sp., *E.* [illegible] sp., *Mylothris* sp., *Papilio* [illegible] and *Terinos* sp. The principal species of the "palatable" group are [illegible], [illegible] sp., *Elymnias undularis*, *Papilio demoleus*, [illegible], *Hypolimnas misippus*, [illegible], [illegible] and [illegible].

	Nauseous.		Palatable.	
	A.	R.	A.	R.
Crateropus canorus	111+	36	96	1
Leiothrix luteus	52	22	94	21
Dissemurus paradiseus	30+	22	54	6
Dicrurus ater	17	2	32	4
Kittacincla macroura	21	28	78	12
Sturnus menzbieri	17	16	42	7
Chloropsis sp	6	5	16	5
Malacias capistrata	0	0	5	5
Otocompsa emeria[78]	21	7	7	6
Molpastes bengalensis[79]	15	1	10	0
Molpastes leucotis	15	0	5	0
Pycnonotus sinensis	7	9	10	1
Turnix taigoor	29	1	20	3
Acridotheres tristis	2	1	2	1
	343+	150	471	72

Finn's conclusions may be discussed in order:

1. "That there is a general appetite for butterflies among insectivorous birds, even though they are rarely seen when wild to attack them" (p. 667).

This is a thing which can never be proven by experiment. As well say there is a general appetite for boiled rice, bread and milk, and domestic cockroaches which were the stock foods of the birds used in these experiments. Certainly, these things are no more foreign to the natural dietaries of many species of birds than are butterflies, and the eating of either in captivity is no proof that they are taken or even relished by wild birds. This argument is strengthened by the record of the button-quail (*Turnix taigoor*) in Finn's experiments. This essentially ground-loving bird, which is in no way equipped for capturing butterflies under natural conditions, and consequently cannot have an appetite for them, in captivity took all but four out of a total of fifty-three that it tried.

Mason and Lefroy, in the most comprehensive and valuable statement yet published regarding the food of birds in India, say:[80] "Butterflies do not form any appreciable proportion of the food of

[78] Finn records the refusal of *Acræa* by the red-whiskered bulbul (p. 640), while Poulton (*Proc. Ent. Soc. Lond.*, 1908, p. xxxi) publishes a letter from H. L. Andrewes, which states that this bird was observed to feed to its young *Acræa violæ*, supposedly one of the most distasteful of the group.

[79] An interesting case of the diversity in results of experiments, and a proof, therefore, of their misleading character, probably refers to this bird, the common bulbul of India. A. G. Butler (*Nature*, 3, No. 61, December 29, 1870, p. 165) notes that a Mr. Newton, of Bombay, said it was only by repeated persecution that a caged bulbul was induced to touch a *Danais*. The record of this bird with *Danais* in Finn's experiments is A 8 R 4.

[80] *Mem. Dept. Agr. India*, Ent. Ser., Vol. III, January, 1912, p. 338.

any one species of bird, though a good many birds take these insects at times. A long series of experiments with regard to birds taking protectively colored or distasteful insects and especially butterflies was made by Mr. Finn. . . . . They have little importance to economic ornithology, since most of the experiments were conducted with caged birds, these, therefore, being under unnatural conditions."

2. "That many, probably most species, dislike, if not intensely, at any rate in comparison with other butterflies, the "warningly colored" Danainæ, *Acræa violæ*, *Delias eucharis*, and *Papilio aristolochiæ;* of these the last being the most distasteful and the Danainæ the least so" (p. 667).

By consulting the tabulation of acceptances and rejections given above, it will be seen that only two out of fourteen species of birds considerably experimented with failed to take as many or more insects of the "nauseous" group than they refused, and that seven of these fourteen species refused as large or a larger proportion of the "palatable" butterflies as of the "nauseous" ones. Consequently the assertion in Conclusion 2, at least as regards the Danainæ, is not borne out even under experimental conditions; it should read, about half of the species of birds considerably experimented with showed in captivity a greater or less degree of preference for butterflies of the "palatable" group. The figures show that about 30 per cent. of all "nauseous" butterflies tested were refused, as were about 13 per cent. of the "palatable" ones. About 23 per cent. of the Danais (average of three species) and of the Euplœas were rejected, proportions nearly as small or smaller than in the case of at least three species of the so-called palatable group, namely, *Papilio demoleus*, 25 per cent.; *Atella phalanta*, 22 per cent.; and *Elymnias undularis*, 24 per cent.

The approximate numbers of refusals and acceptances and the percentage of refusals for the important species of both groups are given below:

"Nauseous" group.

	A.	R.	% R.
Danais chrysippus	136+	38	21.8
" *genutia*	59+	23	28
" *limniace*	38+	9	19.1
Delias eucharis	13	19	59.3
Euplœa sp	53	16	22.8
Euproctis sp	11	2	15.3
Mylabris sp	1+	1	50
Papilio aristolochiæ	17	33	66
Terias sp	11	4	26.6
Acræa violæ	3	5	62.5

"Palatable" group.

Atella phalanta	16	6	22.7
Elymnias undularis	25	8	24.2
Hypolimnas misippus	13	1	7.1
Nepheronia hippia	12	1	7.6
Papilio demoleus	69	24	25.8
" *polites*	55	12	17.9

3. That the mimics of these are at any rate relatively palatable and that the mimicry is commonly effectual under natural conditions" (p. 667).

According to the figures obtained by me, the mimics, *Hypolimnas misippus* and *Nepheronia hippia* were each rejected once in thirteen and twelve trials, respectively, an average of about 7 per cent., or much under the average for the "palatable" group as a whole, while about 18 per cent. of the *Papilio polites* and 24 per cent. of the *Elymnias undularis* were refused, fully as large a proportion as in the case of several members of the "nauseous" group.

There is no more evidence for the latter half of this conclusion than that any other features of the experiments are analogous to natural conditions.

As noted above, the experiments and conclusions of Finn are often quoted in support of the selectionist theories, and Finn himself in summing up this earlier work says: "On the whole, the theory of Wallace and Bates is supported by the facts detailed in this and former papers, so far as they deal with birds (and the one mammal used)" (pp. 667, 668).

It is of great interest, therefore, to note that the builder of these oft-sought bulwarks of the selectionists later came to the opinion that neither they, nor any other of the defenses brought forward, would save the day for the selection theories. In collaboration with Douglass Dewar, in a book entitled *The Making of Species* (1909), he says: "Many naturalists, especially Dr. Wallace and Prof. Poulton, have pushed the various theories of animal coloration to absurd lengths (p. 171). . . . . We have examined these mighty images of gold, and silver, and brass, and iron, and found that there is much clay in the feet" (p. 172) . . . . What we "know of the struggle for existence offers but poor support to the Neo-Darwinian explanation of the cases of the so-called mimicry in nature" (p. 240).

As a result of his experience with captive birds, Finn recommends that future experimenters use birds in a state of freedom, and at

least one experimenter, Lieut.-Col. Neville Manders, has done so. Manders himself says: "I am extremely doubtful as to any real value accruing from experiments on caged birds, whether nestlings or adult. No one, I imagine, believes that all butterflies taste alike; no doubt some are more tasty than others, and caged birds fed upon butterflies, even with other insect food, would no doubt learn in time to distinguish the different kinds; but this procedure to my mind begs the question, as it assumes that butterflies are an ordinary article of food in the wild state, a proposition . . . . which the evidence . . . . does not altogether support."[81] It is noteworthy that the free birds Manders did induce to take disabled butterflies were not seen by him to attack these insects under normal conditions. He frequently comments (pp. 736–739, 741) on this fact. Although the birds ate the helpless butterflies, they took no notice of the freely flying ones that abounded in the vicinity.

The wild birds experimented upon in Ceylon by Manders, with their records, are as follows: (Disregarded—D.—means simply not taken and not tried. Behavior toward dead butterflies not noted).

		Nauseous group.			Palatable group.		
		A.	R.	D.	A.	R.	D.
Robin flycatcher,	*Siphia hyperythra*	2	0	2	6	0	1
Dusky-blue "	*Stoparola sordida*	7	0	0	2	0	4
Brown shrike,	*Lanius cristatus*	4	0	7	4	0	5
Magpie robin,	*Copsychus saularis*	10	3	4+	21+	0	6
Mynah,	*Acridotheres tristis*	11	0	1	5	0	1
		34	3	14+	38+	0	17

Thus there were no refusals (upon trial) of any living butterflies except by the magpie robin. This bird has three rejections, two of *Euplœa core*, one of which it ate immediately afterwards. The bird's record with this butterfly was A 9 R 2. Manders says the other butterfly (*Terias hecabe*) refused by this species was too dry. The percentage of insects disregarded is practically the same for the "nauseous" and the "palatable" groups. Manders' conclusion from this and other evidence is that "the terms palatable and unpalatable are not justified at present" (*l.c.*, p. 742).

Experiments in America.

Unfortunately, the natural food habits of many of the Indian,

[81] *Proc. Zool. Soc. Lond.*, September, 1911, p. 745.

African, and British birds experimented with are not well known, for the selectionists have examined very few stomachs of wild birds. This method is more arduous and does not pile up results so handsomely as do experiments. But it is, nevertheless, in connection with the strictly correlated examination of contents of other parts of the alimentary canal, and of pellets, and fæces (together with reliable records of individuals seen or collected with food in talon or beak), the only trustworthy method of learning what birds actually eat under natural conditions. And this information only is acceptable proof of the tastes and food preferences of birds or, for that matter, of any other animals.

It is fortunate, therefore, that one series of experiments has been made the results of which can be closely checked with a satisfactory amount of exact information upon the food habits of the same species under natural conditions.

Experiments by Judd and Beal.

The experiments referred to have never been published upon as a whole, though some of the results may be found in the following publications:

BEAL, F. E. L. The Bluejay and its Food. *Yearbook U. S. Dept. Agr.*, 1896 (1897), pp. 205, 206.
Birds of California in relation to the Fruit Industry. Part I, *Bul. 30, Biol. Survey*, 1907, p. 35.
JUDD, SYLVESTER D. Four common Birds of the Farm and Garden. *Yearbook U. S. Dept. Agr.*, 1895 (1896), pp. 410, 414.
The Efficiency of some Protective Adaptations in securing Insects from Birds. *Am. Nat.*, 33, No. 390, June, 1899, pp. 461–484.
The relation of Sparrows to Agriculture. *Bul. 15, Biological Survey*, 1901, pp. 45–48.
The Bobwhite and other Quails of the United States in their economic relations. *Bul. 21, Biological Survey*, 1905, pp. 28, 29, 36, 38, 40, 41, 44–45.

Doctor Judd was at one time very enthusiastic with regard to experiments in feeding birds, and these experiments were initiated and largely carried on by him. They were watched, however, and in part performed by Prof. F. E. L. Beal, the veteran economic ornithologist, who has examined the contents of more bird stomachs than any other person in the world. Prof. Beal was mainly responsible for the discontinuance of these experiments, and I am betraying no secret in asserting that experimental ornithology was abandoned

by the United States Biological Survey because of a direct realization from these trials of the futility of experiments as indications of the food preferences and, therefore, of the economic status of species under natural conditions.

It is not the writer's purpose to give a detailed account of these experiments, but merely lists of the items accepted and rejected, with comments thereon. It will be helpful to consider separately those items which were both refused and devoured. Several discrepancies exist between the statistics here presented and the published accounts previously referred to, but the writer has made the following tabulations directly from notebooks containing daily entries regarding the experiments. He believes these should be accepted as correct, rather than statements in the printed pages that have run the gantlet of editors and proof-readers, whose efforts often have just the opposite result, so far as accuracy is concerned, from that which the exercise of their true functions is intended to insure.

To interpret the bearing of this and the following experiments on the theory of protective adaptations, it should be recalled that the common types of what is called warning coloration are the combinations of black with red, yellow, and white. Metallic colors also are usually classed as warning. Besides the insects, etc., possessing these colors, other groups, for various reasons, are said to be specially defended. Among these are ground beetles (Carabidæ), many of which have acid and nauseous secretions; the true bugs (Hemiptera), nearly all pungently flavored and malodorous; ants, and the stinging wasps and bees (Hymenoptera); the spiders and centipeds with poison fangs; and the millipeds with acid juices. All of these creatures are supposed to be especially protected from the attacks of predaceous animals or, in other words, to be distasteful.

To bring out clearly the attitude of Judd's captive birds toward these categories of "protected" animals, the writer has tabulated the results (as regards the animal food only) of each series (except the shorter ones) of experiments under the following headings: "warningly colored" species, others "specially defended," and "non-protected" species. Of course, the term "non-protected" is not in accordance with the theories of protective adaptations, as the more obscurely colored and innoxious forms thus described are also said to be protected, but chiefly in a more passive way than the other two groups, namely, by concealing coloration. "Non-protected" is therefore used to bring into greater contrast the theoretical attributes of these comparatively poorly "protected" species.

BOBWHITE (*Colinus virginianus*):[82]—

Accepted:

CHÆTOPODA.

Earthworms.

COLEOPTERA.

CARABIDÆ.

Scarites subterraneus (black).

Harpalus erythropus (black, reddish legs).

COCCINELLIDÆ.

Adalia bipunctata (red, black, and yellow).

Epilachna borealis (yellow and black).

SCARABÆIDÆ.

Ligyrus gibbosus (red-brown).

CHRYSOMELIDÆ.

Diabrotica 12-punctata (yellow and black), 2+.

Diabrotica vittata (yellow and black), 2+.

Leptinotarsa decemlineata (yellow and black), three birds ate fifty in five minutes.

LEPIDOPTERA.

PIERIDÆ.

Pieris rapæ larvæ (green, black, and yellow), 2.

SPHINGIDÆ.

Phlegethontius sp. larvæ (green and white), 2.

NOCTUIDÆ.

Agrotis sp. larva.

Rejected:

COLEOPTERA.

COCCINELLIDÆ.

Chilocorus bivulnerus (black and red).

MELOIDÆ.

Melæ angusticollis (dark blue or violet, vesicant body fluids).

HOMOPTERA.

APHIDÆ.

HYMENOPTERA.

TENTHREDINIDÆ, larvæ.

Summary: Colinus virginianus.—

	Accepted.		Rejected.	
	Species.	Specimens.	Species.	Specimens.
"Warningly colored" species	7	59+	2	2
Others "specially defended"	1	1	2	2+
"Non-protected" species	4	5	0	0

[82] Partial account of these experiments in *Bul. 21*, *Biol. Survey*, 1905, pp. 28–29, 36, 38, 40, 41, 44–45.

Thus these bobwhites ate, among other things, three species of strongly flavored yellow and black Chrysomelidæ, or leaf beetles, and two species of equally if not more pungent Coccinellidæ or ladybirds, whose colors of yellow and black and red, black, and yellow are typically "warning." On the other hand, the birds refused one red and black ladybird. It is evident considerations as to color of prey have little weight with the quail. It is worthy of note also that although these birds refused plant lice, birds experimented upon by Mrs. Margaret M. Nice ate large numbers of these insects.

Mrs. Nice's experiments upon bobwhites[83] which have previously been reviewed[84] by the writer clearly bring out the fact that birds will eat in captivity insects which they probably never eat or in some cases never even see in their normal existence. Examples are: house-flies (*Musca domestica*) and mosquitoes; 1350 and 568 of these insects, respectively, were taken at single meals, but undoubtedly they are seldom if ever eaten by wild bobwhites. Silver fish (*Lepisma saccharina*), clothes moths (*Tinea pellionella*), and mealworms (*Tenebrio*) also were eaten by the captive quail, but wild birds probably never have a chance to get these close associates of man.

The writer does not list the results of Judd's trials of quail with various vegetable foods, but only one item was refused, namely, strawberries. These are eaten by wild bobwhites and Judd comments[85] on the fact as follows: "M. B. Waite reports that near Odenton, Md., it sometimes picks ripening strawberries. Yet birds that were kept in captivity several months refused strawberries when they were hungry."

BROADWINGED HAWK (*Buteo platypterus*).—

Accepted:

LEPIDOPTERA.

Basilona imperialis imago (yellow and purplish-brown).

BARTRACHIA.

Bufo sp.

AVES.

MICROPODIDÆ.

Chætura pelagica (fuscous).

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[83] "Food of the Bobwhite." By Margaret Morse Nice, *Journ. of Economic Entomology*, Vol. 3, No. 3, June, 1910, pp. 295–313.

[84] *Journ. Economic Ent.*, Vol. 3, No. 5, October, 1910, pp. 437–438.

[85] *Bul. 21, Biol. Survey*, 1905, p. 36.

FRINGILLIDÆ.
Passer domesticus (nestlings), 3.

There is no record of a refusal by this bird. The toad is supposed to be protected by acrid secretions of glands in the skin.

RUBY-THROATED HUMMINGBIRD (*Archilochus colubris*):—

Rejected:
Small Aphidæ.
" Jassidæ.
" Culicidæ.
" Other Diptera.
" Halticinæ.
" Araneida.

The leaf hoppers (Jassidæ), small flies (Diptera), flea-beetles (Halticinæ), and spiders (Araneida), at least, are common articles in the natural diet of this species.

BLUEJAY (*Cyanocitta cristata*):[86]—

Accepted:
CHÆTOPODA.
Earthworms, 7.
ISOPODA.
Oniscus asellus, 6.
CHILOPODA.
Lithobius sp., 2.
Julus sp., 2.
EPHEMERIDA.
Adults, many.
ORTHOPTERA.
ACRIDIIDÆ.
Dissosteira carolina, 1.
COLEOPTERA.
CARABIDÆ.
Agonoderus pallipes (pale yellow and black), 1.
Anisodactylus discoideus (black and brownish-yellow), 2.
" *rusticus* (brownish-black), 2.
Calosoma scrutator (metallic green, red, and blue), 1.
Chlænius sp., 1.
Galerita janus (black and reddish-brown), 2.
Harpalus caliginosus (black), 1.

[86] Partial account in *Yearbook U. S. Dept. Agr.*, 1896 (1897), pp. 205, 206.

ELATERIDÆ.
Alaus oculatus (black and silvery, with eye-spots).
Elaterid, adult, 1.
Elaterid, larva, 1.

SCARABÆIDÆ.
Allorhina nitida (green and yellow), 1.

LUCANIDÆ.
Passalus cornutus (black), 2.

CERAMBYCIDÆ.
Typocerus sinuatus (black with yellow bands), 5.

CHRYSOMELIDÆ.
Diabrotica 12-punctata (yellow with black spots), 1.

TENEBRIONIDÆ.
Nyctobates pennsylvanicus (black), 1.
Tenebrio obscurus (dark reddish-brown), 1.
Tenebrionid undet., 1.

HETEROPTERA.

PENTATOMIDÆ.
Brochymena sp., 1.

LEPIDOPTERA.
Philosamia cynthia (yellow and purplish-brown), 3 (alive and dead).
Telea polyphemus ad. (mainly reddish-brown, white and black, eye spots on each pair of wings), 1.
Orgyia leucostigma, pupæ, 2.
Hyphantria cunea, larvæ (very hairy), many.
Hairy caterpillar, undet., 1.
Cutworm, 1.

HYMENOPTERA.

APINA, 2.
Agapostemon sp. (metallic green), 1.

ARANEIDA.
Spider, 1.

AVES.

PHASIANIDÆ.
Egg shells.

FRINGILLIDÆ.
English sparrow eggs, 2.

Rejected:

ORTHOPTERA.

BLATTIDÆ.
Stylopyga orientalis (black).

HETEROPTERA.

BELOSTOMATIDÆ.
Benacus griseus (light brown).

COLEOPTERA.

LAMPYRIDÆ.

Chauliognathus pennsylvanicus (yellow and black), 3.

CHRYSOMELIDÆ.

Chrysochus auratus (metallic green and coppery).

LEPIDOPTERA.

PAPILIONIDÆ.

Papilio troilus adult (dark red-brown, white, and bluish-green).

PULMONATA.

LIMACIDÆ.

Limax sp.

AVES.

PHASIANIDÆ.

Hen's egg (whole).

FRINGILLIDÆ.

Passer domesticus (alive), in cage three days.

MAMMALIA.

MURIDÆ.

Mus musculus (alive).

SPERMATOPHYTA.

MORACEÆ.

Morus sp. (berry), 2.

AQUIFOLIACEÆ.

Ilex opaca, berry (red), 2.

Disregarded:

COLEOPTERA.

COCCINELLIDÆ.

Adalia bipunctata (red, black, and yellow), 2.
Hippodamia sp., 1.

CHRYSOMELIDÆ.

Galerucella luteola (yellow and black), 3.

LEPIDOPTERA.

PAPILIONIDÆ.

Papilio turnus ad. Killed, dropped when frightened by observer, not picked up (mainly yellow and black), 1.

HYMENOPTERA.

APINA.

Apis mellifera, worker (brown), 1.

SPERMATOPHYTA.

FAGACEÆ.

Fagus grandifolia, nuts.

MYRTACEÆ.

Citrus sp., whole fruit.

Accepted and Rejected:

ORTHOPTERA.

GRYLLIDÆ.

Gryllus sp., A 1 R 1.

COLEOPTERA.

CARABIDÆ.

Scarites subterraneus (black), A 2 R 1.

HYDROPHILIDÆ.

Hydrophilus triangularis (shining greenish-black), A 2 R 2.

SCARABÆIDÆ.

Ligyrus gibbosus (reddish-brown), A 17 R 2.

HYMENOPTERA.

Bombus sp., A 1 R 1.

Xylocopa virginica, worker (black with yellow hairs), A 1 R 1, male A 1.

MAMMALIA.

MURIDÆ.

Mus musculus (dead), A 3 R 1.

Accepted and Disregarded:

COLEOPTERA.

SCARABÆIDÆ.

Lachnosterna sp. (reddish-brown), A 3 D 2.

HYMENOPTERA.

MYRMICIDÆ.

Tetramorium cæspitum (a minute reddish ant), A 1, D many.

Accepted, Rejected, and Disregarded:

ORTHOPTERA.

BLATTIDÆ.

Blattella germanica (yellow-brown and dark brown), A 16+ R 1 D 1.

COLEOPTERA.

SCARABÆIDÆ.

Dyscinetus trachypygus (black), A 5 R 2 D 2.

LEPIDOPTERA.

Philosamia cynthia, cocoons. One pecked, could not be opened, was left; two others disregarded were afterwards eaten when cut open.

SPERMATOPHYTA.

FAGACEÆ.

Quercus sp. (acorns), A 8+ D several, R.

Disregarded and Refused:

COLEOPTERA.

Leptinotarsa decemlineata (yellow and black), D 1 R 2.

LEPIDOPTERA.

Colias philodice ad. (yellow and black), D 2 R 1.

Summary: Cyanocitta cristata.—

	Accepted.		Rejected.		Disregarded.	
	Species.	Specimens.	Species.	Specimens.	Species.	Specimens.
"Warningly colored" species	12	21+	3	5	4	7
Others "specially defended"	8	12	1	1	1	1
"Non-protected" species	15	29	5	5	0	0

	Accepted and rejected.			Accepted and disregarded.		
	Species.	Specimens.		Species.	Specimens.	
"Warningly colored" species	2	A 3	R 2	0	A 0	D 0
Others "specially defended"	1	2	1	1	1	1+
"Non-protected" species	4	23	6	1	3	2

	Accepted, rejected and disregarded.				Disregarded and rejected.		
	Species.	Specimens.			Species.	Specimens.	
"Warningly colored" species	0	A 0	R 0	D 0	2	D 3	R 3
Others "specially defended"	0	0	0	0	0	0	0
"Non-protected" species	3	24+	4	5	0	0	0

Imagos of *Philosamia cynthia*, at least, among the things accepted are seldom or never encountered by wild bluejays. This species was imported with its food plant *Ailanthus glandulosus*, and is established in very few places. The cocoons of this species could not be opened by the jay, but when opened for him the pupæ were eaten. Of the items refused, hen's eggs are all too often attacked by wild birds; living birds and mice are frequently killed and eaten, and mulberries also are eaten under natural conditions.

Among things both accepted and rejected, crickets (*Gryllus*) and May-beetles (*Lachnosterna*) are commonly devoured by free birds. The carabid *Scarites* also has been found in the stomach of this species. Beechnuts were disregarded by the captive jay, and acorns were both disregarded and refused, though some were afterwards eaten. Both of these nuts are frequently eaten by wild jays. These instances in themselves are sufficient to show that acceptances and

rejections by captive birds are no guide to the natural tastes of the species.

ENGLISH SPARROW (*Passer domesticus*):—

Accepted:
COLEOPTERA.
SCARABÆIDÆ.
Ligyrus gibbosus (reddish-brown), 1.
SPERMATOPHYTA.
GRAMINÆ.
Panicum sanguinale.
Chætochloa italica.
Chætochloa viridis.
CHENOPODIACEÆ.
Chenopodium album.
AMBROSIACEÆ.
Ambrosia artemisiæfolia.

Rejected:
HETEROPTERA.
PENTATOMIDÆ.
Brochymena arborea (dark brown), 1.
SPERMATOPHYTA.
CICHORIACEÆ.
Taraxacum taraxacum (heads with akenes).

Accepted and Rejected:
SPERMATOPHYTA.
AMARANTHACEÆ.
Amaranthus sp. Refused at 9 A.M. when hungry, but eaten at 11 same morning.

The fruiting heads of dandelion which were refused are a favorite natural food: and Amaranthus seeds, which were refused but eaten two hours later, are commonly eaten by wild birds of this species.

SNOWBIRD (*Junco hyemalis*):[87]—

Accepted:
ORTHOPTERA.
Encoptolophus sordidus (brown).

Rejected:
COLEOPTERA.
COCCINELLIDÆ.
Adalia bipunctata (red, yellow, and black).
SCARABÆIDÆ.
Dyscinetus trachypygus (black).

[87] Partial account of experiments with this and the following two species in *Bul. 15, Biol. Survey,* 1901, pp. 45–48.

Chrysomelidæ.
Lema trilineata (yellow and black).
Meloidæ.
Epicauta sp.
Spermatophyta.
Chenopodiaceæ.
Chenopodium sp. (seeds).

The latter seeds are a common natural food.

White-throated Sparrow (*Zonotrichia albicollis*):—

Accepted:
Heteroptera.
Pentatomidæ.
Murgantia histrionica (orange and black).

Other acceptances and rejections same as with Junco, and same remark applies.

Song Sparrow (*Melospiza melodia*):—

Accepted:
Neuroptera.
Chrysopidæ.
Chrysopa sp., 1.
Orthoptera.
Encoptolophus sordidus (brown), 1.
Coleoptera.
Carabidæ.
Amara sp., 2.
Anisodactylus terminatus (dark brown to greenish-black), 1.
Harpalus pennsylvanicus (black), 1.
Nebria pallipes (black, legs yellow), 1.
Platynus sp., 2.
Pterostichus sayi (green), 3.
Trogositidæ.
Trogosita virescens (metallic green or blue), 1.
Curculionidæ.
Sitones sp., 2.
Homoptera.
Jassidæ (nymphs and adults), 3.
Heteroptera.
Lygæidæ, 1.
Reduviidæ, 1.
Lepidoptera.
Papilionidæ.
Papilio turnus, ad. (mainly yellow and black), 1.
Moths, 2.
Araneida.
Spider, 1.

SPERMATOPHYTA.
CARYOPHYLLACEÆ.
Alsine media (seeds).

Rejected:

COLEOPTERA.
CARABIDÆ.
Various Harpini were refused, but later *Harpalus pennsylvanicus* was eaten.
COCCINELLIDÆ.
Adalia bipunctata (red, black, and yellow), 1.
Hippodamia sp., 2.
SCARABÆIDÆ.
Allorhina nitida (green and yellow).
Lachnosterna sp.
CHRYSOMELIDÆ.
Diabrotica 12-punctata (yellow and black), several.
Lema trilineata (yellow and black).
MELOIDÆ.
Epicauta sp.
LEPIDOPTERA.
ARCTIIDÆ.
Leucarctia acræa, ad. (white, yellow, and black).
HYMENOPTERA.
FORMICIDÆ.
Black ant, probably *Camponotus*.
SPERMATOPHYTA.
CHENOPODIACEÆ.
Chenopodium sp.
POLYGONACEÆ.
Polygonum sp.

Accepted and Rejected:

COLEOPTERA.
CARABIDÆ.
Agonoderus pallipes (pale yellow and black), ate 2, refused others, but next day ate 15 in three minutes.
Chlænius sp., A 1 R 1.
SCARABÆIDÆ.
Dyscinetus trachypygus (black), A 1 R 1.
Trox sp., A 1 R 2.
SPERMATOPHYTA.
AMARANTHACEÆ.
Amaranthus sp. Refused at first, finally starved into eating it.
CICHORIACEÆ.
Taraxacum taraxacum. The opened fruiting head was accepted at the only trial, the closed involucres were at first refused; several days afterwards 3 were eaten.

Summary: Melospiza melodia.—

	Accepted.		Rejected.		Accepted and rejected.		
	Species.	Specimens.	Species.	Specimens.	Species.	Specimens.	
"Warningly colored" species....	4	6	5	6	2	A 18	R 2+
Others "specially defended"......	9	13	3+	3+	0	0	0
"Non-protected" species...........	3	5	2	2	2	2	3

In rejecting the seeds of *Chenopodium* and *Polygonum* this bird refused two favorite items of the food of wild members of its species; the bird was only starved into eating *Amaranthus* seeds, another favorite natural food. Of the rejected insects, *Camponotus, Diabrotica, Hippodamia,* and *Lachnosterna* have been found in collected stomachs. The acceptances include at least one insect, *Papilio turnus,* which the bird probably never gets under natural conditions. The experimenter noted that this butterfly would have easily escaped the bird had it not been confined.

LITTLE BUTCHERBIRD (*Lanius ludovicianus*):[88]—

Accepted:
- CHILOPODA.
  - *Lithobius* sp., 1.
- ORTHOPTERA.
  - ACRIDIIDÆ.
    - *Hippiscus* sp., 2.
- COLEOPTERA.
  - SCARABÆIDÆ.
    - *Copris carolina* (black), 1.
    - *Lachnosterna* sp., 1.
    - *Ligyrus gibbosus* (dead) (reddish-brown), 1.
    - *Osmoderma* sp., 1.
    - *Trichius piger* (greenish-black, reddish-brown, white; both white and yellow hairs), 1.
  - CERAMBYCIDÆ.
    - *Monohammus* sp., 1.
  - MELOIDÆ.
    - *Meloe americana* (bluish-black, vesicating juices), 1.
- HETEROPTERA.
  - PENTATOMIDÆ.
    - *Euschistus* sp., 1.
    - *Nezara hilaris* (green), 1.

[88] Partial account in *Bul. 30, Biol. Survey*, 1907, p. 35.

BELOSTOMATIDÆ.
Belostoma americanum (light brown), 1.
LEPIDOPTERA.
Ceratomia catalpæ larva (black and yellow), 2.
Estigmene acræa, ad. (white, yellow, and black), 2.
Euvanessa antiopa, ad. (reddish-brown, light blue, and yellow), 2.
DIPTERA.
Calliphora sp., 2.
PISCES.
Goldfish, 1.
Micropterus salmoides, 1.
URODELA.
Plethodon cinereus erythronotus (brown and red).
Plethodon glutinosus (black and white), 1.
REPTILIA.
Storeria dekayi (grayish-brown and black), 1.
Heterodon platyrhinus (yellow or reddish and brown or black), 1.
Sceloporus undulatus (gray or brown and black), 1.
AVES.
FRINGILLIDÆ.
Passer domesticus, 3.
VIREONIDÆ.
Vireo olivaceus, 4.
TROGLODYTIDÆ.
Telmatodytes palustris (dead), 1.
MAMMALIA.
Mus musculus, 5.

Rejected:
COLEOPTERA.
EROTYLIDÆ.
Megalodacne heros (black and yellow), 1.
LAMPYRIDÆ.
Chauliognathus pennsylvanicus (yellow and black), 1.
CHRYSOMELIDÆ.
Diabrotica 12-punctata (yellow and black), 4.
MELOIDÆ.
Epicauta vittata (yellow and black), 1.
HETEROPTERA.
PENTATOMIDÆ.
Murgantia histrionica (yellow and black), 1.
LEPIDOPTERA.
Euvanessa antiopa larva (black, spiny), 1, pupa 1.
Hyphantria cunea larva (yellow, brown, and black, very hairy), 2.
Malacosoma americana larva (black, white, and blue, hairy), 1.

Orgyia leucostigma larva (red, black, white, and yellow, hairy tufted), 1.

SPERMATOPHYTA.

ROSACEÆ.

Fragaria sp. (fruit).

Accepted and Refused:

COLEOPTERA.

CARABIDÆ.

Calosoma scrutator (metallic blue, red, and green). The butcherbird seemed to be staggered by the effluvium of one of the first Calosomas given, but devoured it. Later one was offered it rear end first through the wall of the cage; the bird ate part of the viscera, then refused to touch it again. However, he ate two the next day. In all seven were devoured.

SILPHIDÆ.

Silpha inæqualis (black), A 1 R 1.

SCARABÆIDÆ.

Trox sp., A 1 R 1. Both the *Silpha* and the *Trox* were refused in presence of experimenter, but their remains were found in a pellet thrown up by the bird about two hours later.

HYMENOPTERA.

APINA.

Apis mellifera, worker (brown), A 1 R 1; drone, A 1.

MAMMALIA.

MURIDÆ.

Mus norvegicus, A 2 R 2.

It is difficult to believe that a bird acting on principle would refuse *Epicauta vittata* and eat *Meloe americana*. *Diabrotica* is eaten by wild individuals of the species, and *Silpha*, which was both accepted and rejected by this bird, is a common capture. Calosomas also are frequently eaten by wild butcherbirds.

Summary: Lanius ludovicianus.—

	Accepted.		Rejected.		Accepted and rejected.	
	Species.	Specimens.	Species.	Specimens.	Species.	Specimens.
"Warningly colored species"	12	16	8	12	1	A7 R1
Others "specially defended"	4	4	1	2	2	3 2
"Non-protected species"	11	21	0	0	2	3 3

MOCKINGBIRD (*Mimus polyglottos*).—

Twice chose the grasshopper (*Encoptolophus sordidus*) in prefer-

ence to the May-beetle (*Lachnosterna*), although the latter is eaten by wild mockingbirds.

CATBIRD (*Dumetella carolinensis*):[39]—

Accepted:

CHÆTOPODA.

Earthworm.

ISOPODA.

Oniscus asellus, 6.

CHILOPODA.

Julus sp.

ORTHOPTERA.

Green Acridiid.

COLEOPTERA.

CARABIDÆ.

Undetermined, 11.

Agonoderus pallipes (pale yellow and black), 1.

Anomoglossus pusillus (bluish-green, blue, or black).

Bembidium chalceum (coppery to greenish or black).

STAPHYLINIDÆ.

Undet. (with red elytra), 1.

COCCINELLIDÆ.

Undet., 1.

CUCUJIDÆ.

Cucujus clavipes (larvæ), 6.

DERMESTIDÆ.

Dermestes talpinus (black with variously colored hairs), 4.

SCARABÆIDÆ.

Lachnosterna sp.

Onthophagus hecate (black).

CHRYSOMELIDÆ.

Diabrotica 12-punctata (yellow and black).

TENEBRIONIDÆ.

Tenebrio molitor (reddish-brown or black), 2.

CURCULIONIDÆ.

Centrinus scutellum-album (gray).

LEPIDOPTERA.

Euvanessa antiopa, ad. (reddish-brown, light blue, and yellow).

Phlegethontius 5-maculatus, ad. (gray, dark brown, and yellow).

Hyphantria cunea, larva (yellow, brown, and black, very hairy), 5.

DIPTERA.

Calliphora erythrocephalus, larvæ, 56; ad. (metallic blue, eyes dull red), 1.

Musca domestica (black and gray), 2.

[39] Partial account in *Yearbook U. S. Dept. Agr.*, 1895 (1896), p. 410.

HYMENOPTERA.
FORMICOIDEA, 7.
Lasius alienus, 22.
Cremastogaster linearis, pupa, 3.
Formica sp., 7.
Camponotus pennsylvanicus, 8.
ARANEIDA.
Lycosa sp.
PULMONATA.
Limax sp., 3.
SPERMATOPHYTA.
MORACEÆ.
Morus sp., many.

Rejected:
COLEOPTERA.
BUPRESTIDÆ.
Undet., 3 (could not break the insects).
HYMENOPTERA.
Wasp.

Disregarded:
COLEOPTERA.
Passalus cornutus (black).
LEPIDOPTERA.
Euvanessa antiopa, larva (black, spiny).

Accepted and Rejected:
COLEOPTERA.
CARABIDÆ.
Chlœnius sp., A 3 R 5.
TENEBRIONIDÆ.
Nyctobates pennsylvanicus (black), A 3 R 3.
HYMENOPTERA.
APINA.
Apis mellifera, workers (brown), A 5 R 2.
PULMONATA.
Snail (large), R 1; (small), A 2.
SPERMATOPHYTA.
ROSACEÆ.
Strawberry (*Fragaria* sp.), A several, R several.
AMYGDALACEÆ.
Cherry (*Cerasus* sp.), A 2 R several.

Accepted and Disregarded:
COLEOPTERA.
LAMPYRIDÆ.
Chauliognathus pennsylvanicus (yellow and black), D 1 A 1.

Of the insects accepted, the larvæ of *Cucujus clavipes*, at least,

which live under the bark of rotting trees, are probably never encountered by wild catbirds, but all offered the captive birds were eaten. Among the forms accepted and rejected, the nauseous metallic-green ground-beetle (*Chlænius*) and the honey-bee (*Apis mellifera*) are eaten by wild catbirds, and both strawberries and cherries are favorite foods, as cultivators to their sorrow well know. A wasp was rejected by the captive birds, but many wasps have been found in stomachs of wild catbirds. The soldier-beetle (*Chauliognathus pennsylvanicus*), both disregarded and accepted in the experiment, is eaten under natural conditions.

Summary: Dumetella carolinensis.—

	Accepted.		Rejected.		Disregarded.	
	Species.	Specimens.	Species.	Specimens.	Species.	Specimens.
"Warningly colored" species	9	16	0	0	0	0
Others "specially defended"	10	62	1	1	1	1
"Non-protected" species	11	80	1	3	1	1

	Accepted and rejected.			Accepted and disregarded.		
	Species.	Specimens.		Species.	Specimens.	
"Warningly colored" species	1	A 3	R 5	1	A 1	D 1
Others "specially defended"	1	5	2	0	0	0
"Non-protected" species	3	5	4	0	0	0

BROWN THRASHER (*Toxostoma rufum*):[90]—

Accepted:

COLEOPTERA.

CARABIDÆ.

Harpalus caliginosus (black).

LAMPYRIDÆ.

Chauliognathus pennsylvanicus (yellow and black).

CHRYSOMELIDÆ.

Leptinotarsa decemlineata (yellow and black), twice swallowed and thrown up, then swallowed again and retained.

Diabrotica 12-punctata (yellow and black).

[90] An account of these experiments, with some additional remarks about the bird's preferences for certain human foods and wild berries, is in *Yearbook U. S. Dept. Agr.*, 1895 (1896), p. 414.

MELOIDÆ.
Epicauta sp.
HETEROPTERA.
COREIDÆ.
Anasa tristis (brown).
LEPIDOPTERA.
PIERIDÆ.
Pieris rapæ, larvæ (green, yellow, and black), 3.
ARCTIIDÆ.
Caterpillar, swallowed, but thrown up.

Rejected:
LEPIDOPTERA.
Hyphantria cunea, larvæ (yellow, brown, and black, very hairy).

Both of the insects this captive thrasher seemed to have difficulty in keeping down are eaten in the wild state. All of the other insects accepted belong to "specially protected" species.

BLUEBIRD (*Sialia sialis*):—

Accepted:
ISOPODA.
Oniscus asellus, 2.
ORTHOPTERA.
GRYLLIDÆ.
Gryllus sp., 2.
COLEOPTERA.
CARABIDÆ.
Anisodactylus discoïdeus (black and brownish-yellow).
HYDROPHILIDÆ.
Hydrophilus triangularis (shining greenish-black), ate parts of one broken by bluejay.

Refused:
HYMENOPTERA.
APIDÆ.
Apis mellifera worker (brown).
SPERMATOPHYTA.
AQUIFOLIACEÆ.
Ilex opaca, berries (red).

Disregarded:
COLEOPTERA.
COCCINELLIDÆ.
Adalia bipunctata (red, yellow, and black).

CHRYSOMELIDÆ.

Galerucella luteola (yellow and black), 15 disregarded three times.

HYMENOPTERA.

MYRMICIDÆ.

Tetramorium cæspitum.

Accepted and Disregarded:

COLEOPTERA.

SCARABÆIDÆ.

Lachnosterna sp., A D.

ARANEIDA.

Spider, A 3 D.

Disregarded and Refused:

COLEOPTERA.

CARABIDÆ.

Scarites subterraneus (black), D R 3.

Summary: Sialia sialis.—

	Accepted.		Rejected.		Disregarded.	
	Species.	Specimens.	Species.	Specimens.	Species.	Specimens.
"Warningly colored" species	1	1	0	0	2	16
Others "specially defended"	0	0	1	1	1	1
"Non-protected" species	3	5	0	0	0	0

	Accepted and disregarded.			Disregarded and rejected.		
	Species.	Specimens.		Species.	Specimens.	
"Warningly colored" species	0	A 0	D 0	0	D 0	R 0
Others "specially defended"	1	3	1	1	1	3
"Non-protected" species	1	1	1	0	0	0

This bluebird accepted one insect—*Hydrophilus triangularis*—which very probably is never taken by wild bluebirds. The ground beetle—*Scarites*—disregarded and thrice refused by the captive bluebird has been found in collected stomachs of the species. The same is true of the only berry offered it, that of *Ilex opaca*, which the caged bird rejected. The honey bee, which was refused, and spiders and May-beetles, which were disregarded as well as accepted, are also eaten by wild bluebirds.

General Summary: All species of birds.[91]—

	Accepted	Rejected	Disregarded	Accepted and rejected.		Accepted and disregarded.	
"Warningly colored" species	137+	30	23	A 31	R 10+	A 1	D 1
Others "specially defended"	97	16+	3	10	5	4	2+
"Non-protected" species	152	15+	1	33	16	4	3

	Accepted, rejected, and disregarded.			Disregarded and rejected.	
"Warningly colored" species	A 0	R 0	D 0	D 3	R 3
Others "specially defended"	0	0	0	1	3
"Non-protected" species	24+	4	5	0	0

Totals.—

	Accepted.	Rejected.	Disregarded.	Percentage rejected.	Percentage disregarded.
"Warningly colored" species	169+	43+	27	17.99	11.29
Others "specially defended"	111	24	6+	17.02	4.25
"Non-protected" species	213+	52+	9	18.97	3.28

It appears from this final summary that Judd's captive birds rejected practically the same proportion of the "non-protected" species offered them as of the "specially protected" group. The result, therefore, is quite different from that reached in some other series of experiments. Although it harmonizes with what we believe is the average influence of predaceous animals, as a whole, upon their prey, *i.e.*, an indiscriminate one, it is no more worthy of respect than other experimental results, for the behavior of the animals experimented with did not correspond with the natural habits of their species. This is amply shown by the cases (a few not noted) in which the birds would not eat articles of food that have been found in the stomachs of wild individuals of the same species. This is more than 38 per cent. of all the items (not specimens) offered that were either disregarded or rejected; if so large a proportion of the experimental results are manifestly untrustworthy, the only safe course is to place reliance in none of them.

[91] Includes *Buteo platypterus, Archilochus colubris, Passer domesticus, Junco hyemalis, Zonotrichia albicollis,* and *Toxostoma rufum,* for which no summaries were presented in previous pages.

Bibliography of Other Experiments in America.

An annotated bibliography will sufficiently illustrate the character of other American experiments upon the food of birds. Few of them have any special reference to the efficiency of protective adaptations. The bibliography does not include citations to papers on aviculture nor on the winter feeding of birds. These are very numerous and their only merit from our present standpoint is that they afford much proof, if proof of the obvious were needed, that birds, both free and confined, will readily accept foods with which their species has never had experience under natural conditions.

BOLLES, FRANK. Young Sapsuckers in Captivity. *Auk*, IX, No. 2, April, 1892, pp. 109–119.

Proof that they can live a long time on a diet of syrup with very few insects.

CARPENTER, F. H. Screech Owls Breeding in Confinement. *Ornith. and Oologist*, 8, No. 12, December, 1883, pp. 93, 94.

"I fed them exclusively on frogs. . . . . They seemed to prefer them to any other food, which led me to believe that they constituted no mean portion of their regular fare when at liberty."

This inference is not supported by the results of stomach examinations. Dr. Fisher found frogs in only two out of a total of 255 stomachs examined (*Bul. 3, U. S. Biological Survey*, 1893, pp. 169–173).

COLLINS, C. W. Some Results from Feeding Eggs of *Porthetria dispar* to Birds. *Journ. Economic Ent.*, 3, No. 4, August, 1910, pp. 343–346.

Some English sparrows and a pigeon were tested. In all cases it was necessary to force the birds to eat the eggs. Eggs in dough fed to English sparrow were mostly rejected.

COLLINS, J. W., *et al.* [Food of Young Ruffed Grouse.] *Rep. Comm. Inland Fisheries and Game, Mass.*, 1900 (1901), p. 43.

Some young ruffed grouse which had been fed on maggots, lettuce, and young clover were given grain, and as a result died. Were they also given gravel?

F. G. The Pine Grosbeak in Confinement. *Ornith. and Oologist*, 9, No. 4, April, 1884, p. 41.

Fond of corn meal and milk, apple seeds, beechnuts, and buds and seeds of pine and spruce.

FORBUSH, E. H. [Food consumed by two young crows.] Useful Birds and Their Protection. *Mass. Bd. Agr.*, Boston [1907], pp. 45–48.

Chiefly concerns the quantity of food. Toads, frogs, and salamanders, often stated to be "distasteful," were eaten.

FORBUSH, E. H., and FERNALD, C. H. The Gypsy Moth, *Porthetria dispar* (Linn.). *Mass. State Bd. Agr.*, 1896.

On pp. 231 and 239 it is stated that gypsy moth eggs were fed to a confined English sparrow and a crow. The former ate them voluntarily, but "did not appear to relish them"; the latter would not take them except when they were concealed within other food.

It will be noted that in Collins' experiment (see above) the English sparrow took the eggs only when they were forced upon it.

HERRICK, F. H. The Home Life of Wild Birds. New York, 1901.

Young kingfishers rejected raw meat, but throve on fish in captivity (p. 92).

HODGE, C. F. Our Common Birds. *Nature Study Leaflet*, Biol. Ser. No. 2, Worcester, Mass., 1899.

A young cedarbird took flies, poke berries, cabbage worms, "edema" larvæ, ants, fall web worms (a little sparingly), bush cranberries, and peppermint drops (p. 15). Mockingbirds accepted mealworms and spiders (p. 19).

HODGE, C. F. [Food of Young Ruffed Grouse.] *Rep. Comm. Fisheries and Game, Mass.*, 1903 (1904), pp. 182, 183.

"I tested them with a great variety of prepared foods—grated egg, bread crumbs, scraped raw meat, grated boiled meat, grits, boiled rice, millet and other small seeds, grass, clover, chickweed, partridge, and wintergreen berries, etc. They would either pay no attention to any of these things, or, if they did pick at them at all, would not do so but once." Foods accepted were sweet curds, earthworms, mosquito larvæ, plant lice, mealy bugs, thrips, mealworms and maggots.

HODGE, C. F. A Summer with the Bluebirds. *Bird Lore,* 6, No. 2, March–April, 1904.

"In my series of feeding tests I brought in a number of potato beetles and thoughtlessly dropped a large larva into an open mouth, before observing whether they would take them of their own accord. I noticed that they picked them up once apiece, wiped their bills in disgust, and declined to touch them again. Next morning one of the birds was dead under the perch" (p. 45).

HODGE, C. F. [Food of Young Ruffed Grouse.] *Rep. Comm. Fisheries and Game, Mass.*, 1904 (1905), pp. 132, 133.

Gives a long list of foods accepted; pears and peaches were scarcely more than tasted; thorn-apples, barberries, and black alder berries were not refused, but were taken in large quantities; they took quantities of all sorts of leaves except grape, snowball, artichoke, and *Rosa rugosa.*

Thorn-apples and black alder berries are commonly eaten by wild ruffed grouse. See *Biological Survey, Bul. 24,* 1905, pp. 36–38.

HODGE, C. F. [Food of Ruffed Grouse in Confinement.] *Rep. Comm. Fisheries and Game, Mass.*, 1905 (1906), pp. 65–68.

Gives names of numerous food items accepted. Berries of black alder were taken sparingly; oats and barley were eaten sparingly; peas and beans were refused.

HODGE, C. F. [Food of Young Ruffed Grouse.] *Rep. Comm. Fisheries and Game, Mass.*, 1907 (1908), p. 70.

Two died from swallowing objects too large to pass into gizzard (black cricket and large spider). This certainly was not the cause of death. A young ruffed grouse's digestive apparatus would quickly dispose of two such soft-bodied insects.

HODGE, C. F. [Report . . . . relative to the Propagation of Ruffed Grouse and Quail in Confinement.] *Rep. Comm. Fisheries and Game, Mass.*, 1908 (1909), pp. 60–69.

On pp. 60 and 61, Hodge says: "I encountered a new difficulty against which we must be on our guard in the future. Striped plant bugs were abundant on the grass, and were easily obtained by sweeping with insect nets. The young chicks [of ruffed grouse] ate them greedily, and simply went to sleep and died as if they had been chloroformed. These bugs had the strong odor of squash bugs, by feeding which to toads Conradi found that they died as though they had been poisoned with chloroform."

"Conradi found that five or six squash bugs might be sufficient to kill a toad, and Miss Morse has fed as many as eleven to a bobwhite at a single meal. Plant bugs are not so strong as squash bugs, and I have observed a toad eat over 250 of them in a day without showing ill effects. Still, while this evidence is not conclusive, ... I think that we should be more careful in future not to feed too many strong-smelling bugs to young grouse chicks."

Dr. Hodge's experience with the young grouse, and the bluebird, above noted, being killed by eating certain insects, is unsupported by other testimony, and the observations leading to his conclusions are not scientifically exact.

The reference to Conradi's experiments is incorrect. The toads when confined in small bottles were killed by the vaporized secretions of squash bugs; they were not killed by eating the bugs. The feeding of bobwhites is described on pp. 64–67. He justly remarks: "The most careful artificial feeding of a flock in confinement cannot approach in variety the food of wild birds" (p. 64). Reports of the Massachusetts Commissioners on Fisheries and Game for other years contain notes on the feeding of game birds in captivity, but not in relation to "protected" insects.

HYSLOP, J. A. The False Wireworms of the Pacific Northwest. *Bul. 95, U. S. Bur. Ent.*, Part V, 1912.

In the discussion of natural enemies (p. 84) are reports on experimental feedings of adult *Eleodes* chiefly to various gallinaceous birds. Chickens, ducks, the Reeves pheasant, and silver pheasant ate the beetles, while turkeys refused them, and golden and Lady Amherst pheasants would not notice them. The author says, "However, these birds seemed quite annoyed by our presence and might have eaten the beetles had they not been frightened."

JENKINS, W. E. [Blue Jay in Confinement.] *Ornith. and Oologist*, 9, No. 3, March, 1884, p. 36.

Principal foods are meat, beechnuts, and corn.

NASH, C. W. The Birds of Ontario in relation to Agriculture. *Ont. Dep. Agr.*, Toronto, 1901.

On p. 44 are the results, as to quantity of cutworms and earthworms, experimentally fed to a young robin.

OWEN, D. E. Notes on a Captive Hermit Thrush. *Auk*, XIV, No. 1, January, 1897, pp. 1–8.

Notes on quantity of earthworms and beef eaten. Worms from manure hill refused, those from garden eaten.

PECKHAM, E. G. [Fowls Eating *Argiope riparia*]. *Occas. Papers, Nat. Hist. Soc. Wis.*, I, 1889, p. 72.

This deep black and brilliant yellow spider seems to lack "one means of defence common among conspicuous creatures, *i.e.*, the possession of a nauseous flavor." "Some chickens, to which she was offered, ate her with relish."

REIFF, W. Some Experiments on the resistance of Gypsy Moth Eggs to the Digestive Fluids of Birds. *Psyche*, 17, No. 4, August, 1910, pp. 161–164.

Eggs concealed in other food were fed to a German canary, a chaffinch, a yellow hammer, a Japanese robin, a screech owl, and a carrier pigeon. The eggs given to the first three birds were put in pieces of bread. In each case part of them were picked out and rejected.

For a more complete review of the various experiments in feeding gypsy moth eggs to birds, see *Auk*, 28, No. 2, April, 1911, pp. 285, 286.

SCOTT, W. L. Baltimore Oriole. *Ornith. and Oologist*, 8, No. 11, November, 1883, p. 86.

"He is particularly fond of hard-boiled egg, bread, and finely chopped meat."

STICKNEY, J. H., and HOFFMANN, R. Bird World, Boston, 1898.

An unconfined yellow-throated vireo took cankerworms and many black ants (pp. 106–112).

TREADWELL, D. [The Food of Young Robins.] *Proc. Boston Soc. Nat. Hist.*, VI, 1859, pp. 396–399.

Discusses amount of earthworms and beef eaten per day.

WEED, C. M., and DEARBORN, N. [Food of a Captive Crow.] Birds in Their Relations to Man, 1903, pp. 61, 62.

On quantity of fish consumed.

WHEELOCK, I. G. Nestlings of Forest and Marsh, Chicago, 1902.

Young bluebirds were fed yolk of hard-boiled eggs, cracker crumbs, and earthworms (p. 34).

SUMMARY.

From the writer's point of view, three main conclusions regarding the experimental tests of the efficiency of protective adaptations

against natural enemies are unavoidable: (1) The experiments are very inconsistent; (2) They have been misinterpreted, and (3) They are not trustworthy guides to behavior under natural conditions.

The Experiments are very Inconsistent.—Inconsistency in the details of various series of experiments have been set forth in previous pages (see pp. 298, 300, 313, 316 and 319). Inconsistency in the results of entire series is plainly shown by the strongly contradictory conclusions different experimenters have drawn. Thus Weir, Poulton, Marshall, Pocock, and Finn, for instance, thought their experiments supported the selectionist theories concerning protective adaptations, while Butler, Manders, Punnett, Plateau, Reighard, and Pritchett, among others, drew just the opposite conclusion. Beddard's opinion was that distastefulness was not more definitely associated with conspicuous colors, than with plain ones. The characteristic inconsistency of experimental results are described by him in the following language:[92] "None of these experiments are thoroughly satisfactory; it is so difficult to interpret them, and they are often contradictory, for a bird will eat one day what it has refused before. The experiments that have been made are like most other statistics—they may be made to prove anything."

The Experiments have been Misinterpreted.—This charge weighs not so much against the experiments themselves as against their makers, but it throws doubt upon the desirability of such tests, since the personal equation is so large a factor in the interpretation of results.

Definite instances of misinterpretation have been cited in previous pages (295, 303, 305–316, 325 and 328–330). A chronic case is well illustrated by the following quotations from Prof. E. B. Poulton (*Trans. Ent. Soc. Lond.*, 1902):

"A mantis is probably less affected in this respect [food preferences] by confinement than a vertebrate animal; but the same general criticism will probably hold in both cases—that while the rejection of an insect by a not over-fed insectivorous animal in captivity is evidence of unpalatability or dislike, its acceptance is not sufficient evidence of appreciation or that it constitutes an element of the normal diet. An insect may be eaten readily in captivity which would be rejected or only eaten under the stress of hunger in the wild state" (p. 317).

[92] *Animal Coloration*, 1892, p. 166.

"It has already been pointed out that the acceptance of insects by insectivorous animals in captivity is no proof of their normal likes or dislikes in a wild state. Such acceptance only proves what their action would be when they had been, from some exceptional cause, kept without their normal food in its usual quantity and variety. Hence the fact that Acræas were devoured [by a ground hornbill] is no evidence that they are normally eaten except in a time of unusual hunger. On the other hand, the rejection of two *L. chrysippus*, after three Acræas had been readily eaten, indicate that the former butterfly is decidedly distasteful to this species of bird" (p. 348). . . . .

"*Byblia ilithyia* was . . . . distinguished [by baboons] from an *Acræa*, but this by no means proves that the resemblance is not beneficial under natural conditions (p. 388). . . . . Considering what has been already argued about insect-eating animals in confinement, the acceptances (excluding the Hesperiidæ) probably do not justify the conclusion that the Lepidoptera were palatable, or that they would be sought for in the wild state except under the stress of hunger" (p. 389).

"It has already been pointed out that the refusal or evident dislike of insect food by captive animals is trustworthy evidence of unpalatability, while acceptance is not proof of palatability" (p. 436).

It is self-evident that this oft-repeated dictum is merely special pleading for the admission of as much as possible of the evidence favorable to the theories, and the exclusion of as great a proportion as possible of the evidence that might be unfavorable. So plain is this fact that even Mr. G. A. K. Marshall, collaborator with Prof. Poulton in the paper quoted from, severely criticized the Professor's attitude. He says[93] in part:

"There is too emphatic an insistence upon the possibility of error where an insect is accepted; for it practically casts suspicion upon every such case. On the other hand, the possibility of error in the other direction is not indicated."

The Experiments are not Trustworthy Guides to Behavior under Natural Conditions.—The writer is by no means the first to question the analogy of behavior under experimental to that under natural conditions. The idea is put briefly by L. W. Kline in an article on "Methods in Animal Psychology":[94] "Nothing so shrinks and in-

[93] *Trans. Ent. Soc. Lond.*, 1908, p. 140.
[94] *Amer. Journ. of Psychol.*, 10, 1898–9, p. 276.

hibits completely the fulness and variety of an organism's activities than prison life and fear."

In groups as low even as the Amphibia behavior in confinement is far from natural. Prof. C. O. Whitman found that *Necturus* ordinarily refused food in captivity on account of its extreme timidity. He says:[95] "The first adults which I kept in captivity in a large aquarium refused to eat pieces of raw beef or small fish, whether dead or alive. For months they went on, seeming entirely indifferent to any proffered food, not paying the least attention, so far as I noticed, to tempting morsels dropped quietly in front of them or held in suspension before them. Living earthworms and insect larvæ were presented to them, all of which were known to be palatable to the creature in its natural habitat; but nothing availed to draw attention or elicit any evidence of hunger. Quiet and wholly indifferent in outward behavior, yet the animals were actually starving or wasting away."

Many snakes will not take food in captivity, and it is therefore necessary to force food down their throats to prevent death from starvation. Captivity greatly modifies the behavior of some other reptiles also, as is well stated in the following quotation from H. H. Newman: "In order to understand an animal one must live with it, must spend long hours, quiet days, in thoughtful observation of it, as it pursues its daily round of occupations. This I have had an opportunity of doing, and I now feel that I have a really personal acquaintance with at least five species of tortoises. . . . .

"Studies of this sort should, I believe, precede experimental studies, for sometimes shyness or weariness might be mistaken for stupidity, and sullenness for sluggishness in reaction. As a rule, the more highly organized and alert species of tortoises display, when in captivity, the greatest degree of sullenness, and hence their actions in confinement very poorly represent their true character. The species, on the other hand, that are less highly organized are the species that act more nearly normally when in captivity. . . . . Captivity inhibits normal activity in nearly all tortoises; consequently I abandoned at an early stage of my work the observation of specimens in confinement and devoted myself to long-continued, and at times tedious, observation of the various species as they live in their active environment. . . . .

"Extreme sullenness characterizes the behavior of *Aspidonectes*

[95] *Biol. Lectures*, 1898 (1899), pp. 295, 296.

while in confinement. If kept in a room they hide behind furniture and remain motionless for hours and almost days. When put in aquatic enclosures they immediately bury themselves in the mud and seem to remain there for months. Nothing will induce them to eat or to take any interest in their surroundings. If caught while making their nest, they are sometimes forced to lay the eggs, but never make a nest in confinement. The eggs are simply dropped about on land or in the water, and are usually crushed when found. None of their normal characteristics are in evidence, and it would be a waste of time to attempt to draw conclusions about their disposition or intelligence from their actions in captivity."[96]

Prof. Charles W. Hargitt makes a similar but more general criticism of the experimental method of studying animal behavior, as follows: "I have made the field work emphatic whenever at all practicable. I have elsewhere[97] emphasized the crying need for larger attention to this phase of experimental work, believing that in many cases it is all but impossible to secure trustworthy results as to behavior of animals where the work has been done under such unusual, unnatural, and artificial conditions as most laboratory provisions afford.

"What right has one to assume that the actions of an animal taken rudely from its natural habitat and as rudely imprisoned in some improvised cage are in any scientific sense an expression of its normal behavior, either physical or psychical? Is it within the range of the calculus of probability that conclusions drawn from observations made upon an animal in the shallow confines of a finger-bowl, but whose habitat has been the open sea, are wholly trustworthy? It is no part of my purpose to discredit the laboratory or laboratory appliances as related to such investigations. They are indispensable. But at the same time let it be recognized that they are at best but artificial makeshifts whose values, unless checked up by constant appeal to nature, must be taken at something of a discount. This must be especially the case with higher organisms. Some of these may, of course, be readily domesticated, or made more or less at home in aquaria or vivaria; but not a few absolutely fret their lives out, are never at ease, and probably never give expression to a natural reaction under such conditions. It seems to the writer until one has been able to place his specimens under conditions

[96] "The Habits of Certain Tortoises," *Journ. of Compar. Neurology and Psychol.*, XVI, 2, March, 1906, pp. 126, 127, and 135.

[97] "Observations on the Behavior of Tubicolous Annelids," *Journ. Exp. Zool.*, Vol. 7, 1909, p. 157.

approximating the natural, or has at least brought them to a state of semi-domestication, where in food taking, evidence of health, etc., they are at ease, he has small right to dogmatize as to conclusions, or presume to make such conclusions the basis of so-called *laws of animal behavior*. Not a little of recent investigations along the lines of animal behavior has been vitiated at just this point, and must be repeated to be made trustworthy. The amazing mass of contradictory results which has loaded the literature of recent years is attributable to some extent to this misfortune."[98]

With regard to experimentation with captive birds, Prof. S. A. Forbes, the founder of economic ornithology, says:[99] "This evidently shows only what the bird *will* eat when restrained of its liberty, of such food as may be placed before it, and furnishes few data which we can use with safety in making up an account of its food in freedom, when foraging for itself. The state of confinement is so abnormal for a bird that on this account, also, we can rarely reason from its habits in that state to its ordinary habits. This method is, therefore, available only for the solution of a few separate questions."

The assertions of these authors regarding the modifying effects of captivity upon behavior apply more pertinently to no set of experiments than those which have been conceived to be tests of the food preferences of insectivorous animals in relation to protective adaptations.

The writer has asserted that the experiments are not trustworthy guides to behavior under natural conditions, and he expects to prove this by citing evidence along two lines, viz.: (1) Animals accept in captivity articles of food which they not only do not eat in the wild state, but with which their species probably has never had experience, and (2) animals reject in captivity articles of food which are not only occasionally eaten by wild members of the species, but which may be very important elements of the subsistence as a whole.

(1) *Acceptances.*—This point really needs no proof. Universal experience with the feeding of all kinds of captive animals confirm it. The coarse brown bread (containing oats, shorts and molasses) given to the bears, in some zoological parks, the chopped-up beets, carrots, potatoes, etc., of which the parrots, cranes, and certain rodents are fond, sufficiently illustrate foods relished in confinement by animals

[98] *Journ. of Animal Behavior*, Vol. 2, No. 1, January-February, 1912, pp. 51, 52.
[99] *Bul. Ill. State Lab. Nat. Hist.*, Vol. I, No. 3, 1880, pp. 86, 87.

to which they are unknown in the wild state. The experiments Pocock and Butler, resulting in the acceptance of many Briti insects by a variety of foreign mammals and birds, illustrate the sar point. As noted before, the acceptance of butterflies by some Finn's birds signifies no more, concerning their natural food habi than does their acceptance of boiled rice. It means no more th the eating of silver fish, clothes moths, and mealworms by M Nice's bobwhites.

The point need be no further elaborated. We are forced conclude that acceptance of various items of food by captive anim is no indication whatever that they are eaten by the same speci in the wild state.

(2) *Rejections.*—This point really follows from analogy the co clusion just cited. There is no logic in regarding rejections indicative of natural tastes, when acceptances are plainly shown n to be. But evidence to prove the case is much harder to obtai and it is for this reason that we have been compelled to endure t style of argument that asserts "refusal . . . . is trustworthy eviden of unpalatability, while acceptance is not proof of palatability.".

Fortunately, however, we have information regarding the choi of food by a number of animals, both in captivity and under natu conditions. We have shown that in certain of the experiments wi amphibia, the animals refused articles of food which they habitual eat in the natural state. For instance, this is true of the refu by the common toad of the Eastern United States of millipe (*Julus*), squash-bugs (*Anasa tristis*), and potato beetles (*Leptir tarsa decemlineata*). Prof. Whitman found that ordinary articl of the natural diet were refused by captive *Necturus*. Snakes, particular, often refuse all food in confinement. Is this "trustwortl evidence of unpalatability?" The writer had the care for a year six prairie rattlesnakes (*Sistrurus catenatus*). Live mice and bir put in their cage were killed, but not eaten. No food was tak naturally and they were kept alive only by putting meat well dov their gullets with long-jawed forceps.

Beddard found that a green woodpecker made great objection eating a single earwig, yet Newstead found twenty-three of the insects in the stomach of a wild bird of this species. Finn four that captive red-whiskered bulbuls refused *Acræa*, but an observ in India saw the birds feeding the "most distasteful" insect of tl genus to their young. So little is known regarding the natural foo of birds in most countries that few such comparisons can be mad

Fortunately, this is not the case in the United States, where we have data enough to prove the point.

A selection of the more conspicuous cases of refusal of favorite natural foods by the birds tested by Judd are given in the following tabulation. Other instances are cited in the summaries of the separate experiments (pp. 340, 346, 349, 350 and 351).

Rejected by captive birds.	*Eaten by wild individuals of the same species.*
A ruby-throated hummingbird rejected small leaf-hoppers, flies, flea-beetles, and spiders.	All of these items are commonly eaten by wild birds of this species.
A bluejay refused a hen's egg, living birds and mice, and mulberries. Acorns also were refused.	In a state of nature jays frequently break up outlying nests of fowls. Birds and mice are preyed upon and mulberries are eaten. Acorns have been found in dozens of stomachs of wild birds and are a very important element of the normal diet.
English sparrows rejected fruiting heads of dandelion.	Whole flocks of English sparrows pass days in rifling the ripe involucres of this plant.
A snowbird, a white-throated sparrow, and a song sparrow refused seeds of lamb's quarters.	These seeds are a common natural food of all three birds.
The song sparrow rejected, also, seeds of smartweed and beetles of the genera *Diabrotica*, *Hippodamia*, and *Lachnosterna*.	All are eaten by wild song sparrows, the smartweed seeds in abundance.

These facts show that the feeding reactions of various animals are strikingly modified by confinement. Some animals refuse items of food which are a favorite with wild individuals of the species, some of which may form a notable percentage of the total subsistence. Others refuse all food. The birds experimented upon by Judd together disregarded or rejected 108 articles of food. Forty-two of these items have been found in stomachs of wild birds of the same species that ignored or refused them in captivity. Investigations carried on while this paper was in preparation raised this number to 42 from 35, and it must be borne in mind that subsequent stomach examinations will increase, never diminish the total. The

experimental indications as to what food items are unattractive or distasteful to the birds, thus, are proved to be misleading in 42 cases out of 108. This makes a percentage of error of 38 (which will grow larger), enough to entirely invalidate the data. Furthermore, it is not probable that the data from any other series of experiments are any more reliable. The conclusion cannot be avoided, therefore, that the rejection of various items of food by captive animals does not prove that these items are rejected by the same species under natural conditions.

Conclusion.

It has been demonstrated that behavior of captive animals toward food is not a reliable indication of what wild individuals of the same species would do in the presence of the same food. In other words, since the feeding habits of an animal in captivity may vary widely from its known habits in the natural state, there is no avoiding the conclusion that the results obtained under experimental conditions, do not indicate the part the animal might play in natural selection.

We must conclude, therefore, since acceptances and rejections in experiments bear no close relation to food preferences under natural conditions, that the value of experiments to determine the efficiency of warning colors, and other protective adaptations of prey, is very questionable. Having no certain value in themselves, they must be checked up with definite knowledge of the natural food habits. This information is obtained by collecting animals with freshly captured prey and by examination of pellets, castings, and the contents of stomachs or other portions of the alimentary canal. There is no possibility of going back of such evidence on the choice of food, nor is there any need of so doing.

Since this evidence is sufficient in itself, and since experimental data must be supported by it to be worthy of any consideration, why perform the experiments? The same time expended in collecting trustworthy data regarding the natural food habits of animals would bring much greater returns, and the result would be truth, not imaginative inferences from abnormal behavior.

A NEW SYNALLAXIS.

BY WITMER STONE.

In a collection of birds made by Mr. Samuel N. Rhoads in Ecuador in 1911, and recently acquired by the Academy, there are several specimens of a *Synallaxis* which appears to be undescribed, although individuals of apparently the same form have been taken by previous explorers and referred to *S. gularis*. From typical *S. gularis* Lafr. from Bogota the Ecuador birds differ very decidedly; the upper surface is much darker and less tawny, while the lower parts are uniform pale tawny olive with no rusty tints on the side nor gray on the breast; the white gular patch and superciliaries are not so pure and the white of the lores and frontlet much obscured with brown and gray.

Birds from the Cauca Valley, Colombia, recently described by Mr. F. M. Chapman as *Synallaxis gularis rufipectus*, are much closer to the Ecuadorian form, having the lower parts uniform, with no trace of gray on the breast, but the colors above and below are much brighter and richer, especially the under parts, while the bill seems to average stronger and heavier.

The Ecuador bird may be known as

Synallaxis gularis pichinchæ subsp. nov.

Type, No. 59,432, Collection Academy of Natural Sciences of Philadelphia, ♂, May 1, 1911. Hacienda Garzon, southern foot of Mt. Pichincha, Ecuador, 10,800 ft. elevation. Collected by Samuel N. Rhoads.

Upper parts uniform raw umber[1] with a slight russet tinge, tail chestnut; lower parts uniform pale tawny olive inclining to isabella color, slightly darker on the sides of the body, gular patch rather dull white, narrow superciliaries white, lores gray, with a dull white stripe above, forming the anterior extension of the superciliary. Wing 58 mm. Culmen 12 mm.

A female obtained at the same locality, May 17, and another male, May 5, correspond exactly with the type.

My thanks are due to Mr. F. M. Chapman, curator of ornithology in the American Museum of Natural History, for the loan of specimens of the new forms of this group recently described by him, as well as for typical specimens of *S. gularis*, one of which had been compared with the type. These specimens were invaluable in determining the relationships of the Ecuador bird.

[1] Colors named according to Ridgway's *Nomenclature of Colors*, Boston, 1886.

SILICIFIED WOOD FROM THE TRIASSIC OF PENNSYLVANIA.

BY EDGAR T. WHERRY, PH.D.[1]

The occurrence of silicified wood in the Triassic or "Newark" rocks of the eastern United States was first observed in the Richmond Basin, Virginia, by Thomas Nuttall in 1821,[2] and it was shortly afterward discovered in North Carolina[3] and in Connecticut,[4] but its presence in Pennsylvania does not appear to be mentioned in the literature.[5]

The inhabitants of southern Bucks and northern Chester and Lancaster Counties have long recognized the character of specimens of it plowed up in their fields, but its scientific interest was first realized by Mr. John F. Vanartsdalen, of Holland, Bucks County, about 1890, who brought it to the attention of the writer several years later. The western Lancaster County occurrences were discovered independently by Professor H. Justin Roddy, of the Millersville State Normal School. Subsequent search has greatly increased the number of localities, so that it is now known to occur at short intervals along the strike of the Triassic rocks, near their base—the southern edge of the belt, since the dip is for the most part gently northward—from the Delaware River to beyond the Susquehanna, a distance of over 100 miles. These relations are well brought out in the accompanying sketch map and geographical table.

TABLE I. LOCALITIES OF SILICIFIED WOOD.

B. *Bucks County.*

1. Roelofs: Farm of George W. DeCoursey, ¼ mile southeast of the station.
2. Woodbourne: On several farms 1½ miles north of the station.

[1] This paper, the fourth of the writer's studies on the Triassic, was presented in preliminary form at the meeting of the Academy in association with the Mineralogical and Geological Section on May 18, 1909, but publication was deferred until opportunity for completing the work could be obtained, the final results being announced at the similar meeting on May 21, 1912.

[2] Observations on the Geological Structure of the Valley of the Mississippi, [etc.], *Jour. Acad. Nat. Sci. Phila.*, II, i, p. 37.

[3] Olmsted, D. Descriptive Catalogue of Rocks and Minerals Collected in North Carolina, *Amer. Jour. Sci.*, [1], V, p. 261, 1822.

[4] Hitchcock, E. Miscellaneous Notices of Mineral Localities, with Geological Remarks, *Amer. Jour. Sci.* [1], XIV, p. 228, 1828.

[5] Compare, however, Prof. O. C. S. Carter: A Ferruginised Tree, *Jour. Franklin Inst.*, CXLI, pp. 227–229, 1896, which perhaps refers to similar material.

3. Newtown: Bed of Neshaminy Creek, 1½ miles west of the town.
4. St. Leonard's: Roadside northeast of station.
5. Rocksville (Holland P. O.): Fields along north bank of Mill Creek.
6. Holland: Fields south and southeast of the station.
7. Churchville: Fields east of station.
8. Center Hill: Fields along ridge just northwest of village and for 2 miles southwestward.
9. Spring Valley: Fields 1 mile to the southwest.
10. Doylestown: Fields 1½ miles south of the town.

M. *Montgomery County.*

1. Morganville: Trenton Cut-Off R. R. cut ¼ mile east of station.
2. Jarrettown: Sand quarry ½ mile northwest of cross-roads.
3. Maple Glen: Sand quarry south of house of William Teas, ¼ mile east of cross-roads; this is the "ferruginized tree" locality.

C. *Chester County.*

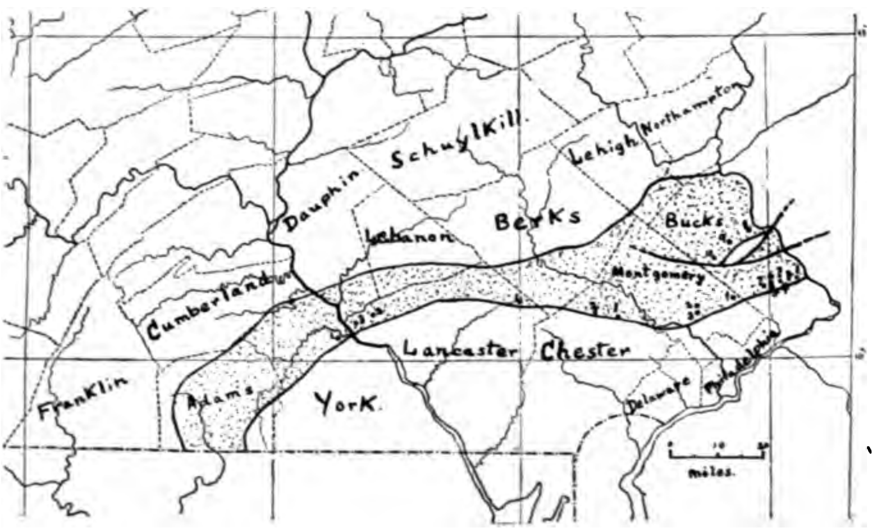
1. Sheeder: Roadside ¾ mile northeast of cross-roads.
2. Coventryville: Fields on farm of Isaac D. Rosen, ¼ mile east of the village.

L. *Lancaster County.*

1. Churchtown: Fields 2 miles northwest of town.
2. Elizabethtown: Penna. R. R. cut ½ mile southeast of station; also in fields east and southwest of town.
3. Bainbridge: On several farms about 3 miles to the northeast; and on that of Omar Baughman, one mile north of the town.

Y. *York County.*

1. York Haven: In fields about 2 miles to the south and southeast.



The wood occurs in fragments of all sizes, up to complete trunks a foot or more in diameter and several feet long. It is usually dark brown in color, and almost entirely replaced by granular to minutely crystalline quartz,[6] with occasional carbonaceous streaks. Its original vegetable character is almost always evident to the naked eye, although annual rings are never visible; and thin sections, which are readily prepared by grinding with carborundum, after the manner of making ordinary rock-sections, show under the microscope every structural detail beautifully outlined in brown. While usually found loose in the fields or along the roads, it has been observed in place in several localities, and is always associated with the highly arkosic sandstones or conglomerates which mark the lower portions (Norristown or Stockton formation) of the Triassic. It is not limited to any narrow horizon, however, but occurs at various levels throughout a thickness of at least 5,000 feet of beds, locality M. 1, for instance, being at the very base, and B. 3 at the top, of that formation.

The material found outside of Pennsylvania has all been referred to three species, *Araucarioxylon virginianum*, *A. woodworthi*, and *Cedroxylon huttonianum ?*, the first being the most widely distributed. As a result of the examination of some sixty specimens, about half of which were sectioned by Mr. Vanartsdalen, two new species have been recognized, which are here described as *Araucarioxylon vanartsdaleni* and *Brachyoxylon pennsylvanianum*. The present paper is not to be regarded as the last word upon the subject, however, as it is possible that the discovery of additional material may throw further light on the status and relationships of these species.

Genus ARAUCARIOXYLON Kraus.

Araucarioxylon virginianum Knowlton. Plate III, figs. 1-3.

Fossil Wood and Lignite of the Potomac [and Newark] Formation, Bull. U. S. Geol. Surv., No. 56, pp. 50–52, pl. VII, 1889. A Revision of the Genus Araucarioxylon of Kraus, Proc. U. S. Nat. Mus., XII, p. 615, 1889, and Amer. Jour. Sci., [3], XL, p. 257, 1890. Report on some Fossil Wood from the Richmond Basin, Virginia, Ann. Rept. U. S. Geol. Surv., XIX, pt. ii, pp. 516, 517, pl. LII, 1899. Description of a Small Collection of Fossil Wood from the Triassic Area of North Carolina, Ann. Rept. U. S. Geol. Surv. XX, pt. ii, pp. 272–274, pl. XXXVII, 1900. Report on Fossil Wood from the Newark Formation of South Britain, Conn. Ann. Rept. U. S. Geol. Surv., XXI, pt. iii, pp. 161, 162, 1901.

TRANSVERSE SECTION: Annual ring indistinct; tracheids thick

[6] Chemical analysis of a Lancaster County specimen (from L. 3) by Prof. Miles Timlin, of the Millersville State Normal School, showed: SiO_2, 96.5%; Fe_2O_3, 1.2%, the remainder being carbonaceous matter. Cf. Pl. IV, fig. 6.

walled, moderately large (about 0.04 mm. in diameter) in radial rows.

RADIAL SECTION: Tracheids long, thick walled; bordered pits in one or frequently two series; when in one, in contact and flattened; in two, closely packed, alternate, strongly hexagonal, and nearly covering the walls of the cells (diam. 0.016 to 0.021 mm.); medullary rays long, without pits; resin ducts none.

TANGENTIAL SECTION: Rays simple, of 1 to 27, usually 10–12 cells about 0.025 mm. in diameter; no pits on walls, but cross-sections of radial wall pits prominent.

OCCURRENCE: This species, hitherto found near the base of the Triassic in North Carolina, Virginia, and Connecticut, is now reported for the first time from Pennsylvania, being occasionally found at localities B. 2 and B. 5.

RELATIONSHIP: *Araucarioxylon* (*Dadoxylon*) *rhodeanum* Göppert, from the Permian of Silesia, appears from descriptions to be very similar to this species, but distinctive features would no doubt be found if well-preserved specimens could be compared.

Araucarioxylon vanartsdaleni sp. nov. Plate III, figs. 3–6.

TRANSVERSE SECTION: Annual ring indistinct; tracheids averaging 0.03 mm. in diameter, thick walled.

RADIAL SECTION: Tracheids long, thick walled, with bordered pits (diam. 0.015–0.020 mm.) usually in single rows, barely touching, and but little compressed; about one cell in every fifty with double rows, which are alternate and hexagonal; medullary rays long (at least, no partitions preserved), without pits; resin ducts absent.

TANGENTIAL SECTION: Ray cells rather small (diam. 0.02 mm.), up to 10 in one row, though usually 5 or 6; pits absent.

OCCURRENCE: This appears to be the most widespread form in the Triassic of Pennsylvania, occurring at practically every locality on the list.

RELATIONSHIP: When first examined all of the wood with contiguous pits was referred to *A. virginianum*, but the study of a large number of specimens indicates that there are probably two distinct species represented, and the one characterized here differs from *A. virginianum* as well as from *A. woodworthi* Knowlton, which occurs near the top of the Triassic in Virginia, in the fewer-celled medullary rays and the predominance of the uniserial arrangement of the pits. It is therefore regarded as new, and named after its discoverer. Its nearest relative in other regions is *A. würtemburg-*

iacum Göppert, which is a Jurassic form, but there is no reason to suppose them to be really identical.

Genus **BRACHYOXYLON** Hollick and Jeffrey.

Brachyoxylon pennsylvanianum sp. nov. Plate IV, figs. 1–5.

Cedroxylon ? pennsylvanianum, the writer's communication to the Academy, May 18, 1909. *Peuce huttoniana* Witham ? Rogers, W. B.: [Exhibition of Specimens, with Remarks.] Proc. Boston Soc. Nat. Hist., V, pp. 17, 18, 1854.

Transverse Section: Annual ring distinct; tracheids about 0.035 mm. in diameter, medium walled.

Radial Section: Tracheids long, medium walled; bordered pits, 0.010 to 0.012 mm. in diameter, in one or rarely two series, circular, not quite touching, when double in part distant and subopposite, yet in other places in the same sections alternating and hexagonal; medullary rays long, without pits; resin ducts absent.

Tangential Section: Rays simple, containing from 2 to 30 cells, usually 7–9, about 0.02 mm. wide; no bordered pits visible.

Occurrence and Relationships: While the majority of the specimens of silicified wood show the araucarian type of structure, a few fragments, found at four or five localities, differ in having distinctly separated and more or less opposite bordered pits. According to Kraus's classification, this material should therefore be referred to the genus *Cedroxylon*, as was done in the writer's preliminary report. But the variation in the character of the pits in different parts of the same section suggests its probable identity with the new genus *Brachyoxylon* Hollick and Jeffrey,[7] in which both alternating double and non-contiguous single rows of pits are present. The occurrence of this type of structure in so early a geological period as the lower Triassic is interesting, although in the absence of any information as to the leaves or other external characters of the plant, discussion of its relationships or significance would be futile.

In searching for evidence as to the age of the "Middle Secondary" rocks in Virginia, Rogers had made a microscopical examination of silicified wood from both "western and eastern belts" and thought its structure "to agree very nearly with the fossils figured by Witham under the name of *Peuce Huttonia*."[8] He unfortunately never

[7] Studies of Cretaceous Coniferous Remains from Kreischerville, N. Y., *Mem. N. Y. Bot. Gard.*, III, pp. 54–57, pl. XIII, 1909.

[8] Witham, H. T. M. *The Internal Structure of Fossil Vegetables*, p. 70, pl. XIV–XV, 1833; reclassified as *Cedroxylon huttonianum* by Kraus: Schimper's *Traité de Paléontologie Végétale*, II, p. 371, 1870.

published the exact localities from which it had been obtained, but it may have been identical with the species here characterized, although in the writer's opinion this is more like *C. lindleyanum* (Witham) Kraus. Both of these species had been described from the Lias of England, and Rogers accordingly inferred the Jurassic age of the American rocks, but there can be no question that our form is really entirely distinct from either, and it is named after the State in which it was discovered.

The distribution of these species is shown in the following table; material from localities M. 2 and M. 3 could not be obtained for study.

Locality	B. 1	2	3	4	5	6	7	8	9	10
A. virginianum	...	×	...	...	×	...	...	...	...	...
A. vanartsdaleni	×	×	×	×	×	×	×	×	×	×
B. pennsylvanianum	×	×	...	...	×	...	...	...	...	...

Locality	M. 1	2	3	C.1	2	L.1	2	3	Y.1
A. virginianum	...	...	...	...	...	...	...	...	...
A. vanartsdaleni	×	—	—	...	×	×	×	×	×
B. pennsylvanianum	...	...	...	×	×	...	...	...	...

In conclusion, a word may be added concerning the bearing of the fossil wood on the question as to the climate of the Triassic. A prevailing red color in the sediment of any period has now come to be recognized by geologists as an indication that the climate of the time was to some extent arid. The obscurity of the annual ring in these trees may be regarded as pointing to a certain extent[9] in the same direction, for it shows that there could not have been any marked seasonal variation in temperature conditions, and the simplest way in which this could occur would be under the prevalence of a dry climate, caused perhaps by some peculiarity of configuration of continents or elevation of mountains, which produced a different circulation of the atmosphere from that prevailing here at present.

The arkosic matrix of the wood specimens (from the feldspar of which their silica has been derived) is also suggestive of the same state of affairs, for it must have been formed under conditions where disintegration exceeded decomposition, so that the feldspar and other silicates could be broken up without extensive chemical alteration, and although this could result equally well in frigid as in arid climates, there is no direct evidence for the former, so that the

[9] Although the value of this evidence is limited by the fact that living araucarias show little annual ring, even though growing in temperate climates.

latter remains as the most probable climatic condition of the Triassic period in Eastern North America.

Explanation of Plates III, IV.

Plate III.—Fig. 1.—*Araucarioxylon virginianum* Knowlton. Locality B. 5. Transverse section, × 20. No definite annual ring.

Fig. 2.—Same. Radial section, × 40. Shows several double rows of pits.

Fig. 3.—Same. Tangential section, × 40. Shows cross-section of medullary rays and of radial wall pits.

Fig. 4.—*Araucarioxylon vanartsdaleni* sp. nov. Locality B. 5. Transverse section, × 20. No annual ring.

Fig. 5.—Same. Radial section, × 40. Shows one of the very rare double rows of pits.

Fig. 6.—Same. Tangential section, × 40. Shows few-celled rays.

Plate IV.—Fig. 1.—*Brachyoxylon pennsylvanianum* sp. nov. Locality C. 1. Transverse section, × 20. Shows distinct annual ring of four layers of small cells just above middle.

Fig. 2.—Same. Radial section, × 40. Shows single rows of pits, distinctly separated.

Fig. 3.—Same. Tangential section, × 40. Shows medullary rays.

Fig. 4.—Same. Another radial section, × 40. Shows several double rows of pits, which are only partially alternate.

Fig. 5.—Same as figure 4, but × 100.

Fig. 6.—The section shown in Plate III, fig. 3, under crossed nicols (× 40), showing the complete replacement by crystalline quartz.

AGE AND CORRELATION OF THE "NEW RED" OR NEWARK GROUP IN PENNSYLVANIA.

BY EDGAR T. WHERRY, PH.D.[1]

The so-called "New Red" or Newark group of rocks of the Eastern United States has heretofore been almost universally regarded as a geologic and paleontologic unit, and correlated with the Rhætic or uppermost Triassic of Europe. Mr. Benj. Smith Lyman, Director of the Mineralogical and Geological Section, who was the first to make a detailed study of any portion of these beds, found them in eastern Pennsylvania to be unexpectedly thick (27,000 feet) and capable of considerable subdivision, and accordingly put forward the suggestion that the group is not all of the same age, but that its deposition began in some portion of the late Paleozoic and continued throughout the Triassic and perhaps even into the Jurassic.[2] This view was considered briefly by Ward[3] and cast aside, but the question has never been really settled, and is here reopened and discussed in detail.

The Paleozoic age of the lowermost beds was inferred by Mr. Lyman from the supposed occurrence of:

Lepidodendron of Lower Carboniferous type at Newark, N. J.

Calamites of Permian age at Holicong, Bucks County, Pa.

Dendrophycus of Devonian aspect at Portland, Conn.

To which may be added, silicified wood related to Permian species of Europe as described by Knowlton[4] and by the writer.[5]

The identification of the *Lepidodendron* was made by Lesquereux on a photograph of a poorly preserved fragment, and must therefore at best be regarded as doubtful, even had no other examination of the material ever been made. But Newberry[6] and Fontaine,[7] studying the same or a similar specimen, agreed that it represents a conifer, probably *Abies* or *Palissya*, while Berry thinks that "all that can be safely said is that it is the decorticated trunk of a gym-

[1] The subject-matter of this paper has been presented in the form of occasional notes at meetings of the Mineralogical and Geological Section of the Academy.

[2] Age of the Newark Brownstone, *Proc. Amer. Phil. Soc.*, XXXIII, pp. 5–10; and Some New Red Horizons, *ib.*, pp. 192–215, 1894.

[3] Status of the Mesozoic Floras of the U. S., *Ann. Rept. U. S. Geol. Surv.*, XX, pt. ii, pp. 218–221, 1900.

[4] Fossil Wood and Lignite of the Potomac [and Newark] Formation, *Bull. U. S. Geol. Surv.*, No. 56, p. 52, 1889.

[5] Preceding paper.

[6] Fossil Fishes and Fossil Plants of the Triassic Rocks of New Jersey and the Connecticut Valley, *Mon. U. S. Geol. Surv.*, XIV, pp. 94, 95, 1888.

[7] In Ward's Status of the Mesozoic Floras of the U. S., *Ann. Rept. U. S. Geol. Surv.*, XX, pt. ii, p. 219, 1900.

nosperm."[8] As a matter of fact, the building-stone beds, from wh it was obtained, are stratigraphically many thousand feet above base of the Triassic.

The *Calamites* from Bucks County, discovered many years by Mr. John S. Ash, had been identified by Lesquereux as *Calam arenaceus*, a Triassic species,[9] and later by Dr. N. L. Britton[10] *Schizoneura laticostata* (or *planicostata*), a form occurring in Upper Triassic of Virginia. As there still seemed to be a possibili however, that the fossil was of Permian age, the writer in 1 carried on excavations at the locality, and sent the material tl obtained together with specimens of this plant and a cycad p viously collected by Mr. Ash and by the Mineralogical and Geologi Section of the Academy to the United States National Museum identification. It was there examined by Messrs. David White a F. H. Knowlton, the foremost authorities on Carboniferous a Triassic plants, respectively, and they reported as follows:

"The equisetalean stem fragments probably belong to *Schizoneu* with which they accord fairly well. The gymnospermous fragm seems to belong to *Cycadites*, and has many characters in comn with *C. tenuinervis* of the southern Newark. The material affo no evidence of Paleozoic age, the equisetalean specimens be generally unlike the Paleozoic *Calamites* and *Equisetites*, while genus *Cycadites* is unknown in the cosmopolitan Permian flor Though of relatively little value, the data embraced in this collect points toward Triassic age."

The "dendrophycus" is of no diagnostic value because it is inorganic origin, representing a rill-mark,[12] and of course water flov over mud about the same in the Triassic as in the Carbonifer period. So there remains to be considered only the silicified wo Of the three species found in Pennsylvania one has its nearest relat in the Permian of Europe, although the other two are more l Jurassic forms, as pointed out in the preceding paper. The appar similarities would no doubt largely disappear, however, if w preserved material were available for direct comparison, for pr

[8] A Brief Sketch of Fossil Plants, *Ann. Rept. State Geol. N. J.*, 1905, p. 1 note 2, No. 5.

[9] Lewis, H. C. A Great Trap Dyke Across Southeastern Pennsylvai *Proc. Amer. Philos. Soc.*, XXII, p. 453, 1883.

[10] [Exhibition of Specimens.] *Trans. N. Y. Acad. Sci.*, V, p. 17, 1885.

[11] Although Göppert described two species from the Carboniferous limest of Silesia: Beiträge zur Kenntniss Fossiler Cycadeen, *Neues Jahrb. M Geol. Paleont.*, 1866, pp. 131, 132, pl. II. [E. T. W.]

[12] Lull, R. S.: The Life of the Connecticut Trias, *Amer. Jour. Sci.*, XXXIII, p. 403, 1912.

lished descriptions and figures necessarily leave much to be desired as far as really complete characterization is concerned. Furthermore, it is generally recognized that because of the relative stability of internal structures as compared with external characters, identification for purposes of correlation must be based on the latter; indeed, plants may pass from one formation or even period to another with the former apparently unchanged, and of all types of structure that of the araucarias is the most persistent, extending from the Devonian down to the present time.

It appears, therefore, that there is actually not the slightest foundation for the idea that the deposition of the Newark group began during the Permian or any other portion of the Paleozoic. But it is not by any means certain that more than one limited subdivision of the European Triassic may not be represented within its bounds.

For purposes of comparison, a table of the subdivisions which have been recognized both here and in Europe is added.

TABLE I. SUBDIVISIONS OF THE TRIASSIC.

Pennsylvania.[13]	New Jersey.[14]	Great Britain.[15]	Germany.[15]
		Rhætic, 250 feet.	Rhætic, 500 feet.
Pottstown, Perkasie, Lansdale (Brunswick) 16,000 feet.	Brunswick, 12,000 feet.	Upper Keuper, 3,000 feet.	Keuper, 1,000 feet.
			Lettenkohle, 230 feet.
Gwynedd, 3,500 feet.	Lockatong, 3,600 feet.	Lower Keuper, 450 feet.	
			Muschelkalk, 1,000 feet.
Norristown, 5,500 feet.	Stockton, 4,700 feet.	Variegated sandstone, 2,000 feet.	Bunter, 1,500 feet.

[13] Lyman, op. cit., p. 197, and Report on the New Red of Bucks and Montgomery Counties, *Summary Final Report, Penna. 2d Geol. Surv.*, III, pt. ii, pp. 2589–2638, 1895. Thicknesses somewhat modified in accordance with later work.

[14] Kümmel, H. B. The Newark System—Report of Progress, *Ann. Rept. State Geol. N. J.*, 1896, pp. 34–55: thicknesses, p. 59.

[15] Von Huene, F. Eine Zusammenstellung über die Englische Trias, etc., *Centr. Min. Geol. Paleont.*, 1908, p. 16; thicknesses from various sources.

A few words should be added concerning the nomenclature of the American formations. The upper portion of the Newark was divided by Mr. Lyman, as shown in the table, into three members: the Lansdale, a soft red shale, followed by the Perkasie, described as harder and darker in color, and the Pottstown, again soft and red. The writer has not been able to recognize the validity of this subdivision, as the Perkasie at its type locality, as well as at several other places, contains various secondary minerals, such as quartz, epidote, and stilbite and other zeolites, which are seen in microscopic sections to fill the spaces between the grains, and are also often crystallized out in crevices, showing it to be merely a metamorphosed phase of the otherwise soft red sediments. It is therefore most convenient to treat these three formations as a unit, for which the name Brunswick, first applied to the New Jersey area, may well be adopted. For the two lower formations the Pennsylvania names have priority, but since the New Jersey ones have been rather widely used it seems necessary to give both to insure against any misunderstanding.

While the earlier observers were inclined to consider the fossils of the American Newark as equivalent to forms from the Rhætic of Europe—the transition stage between the Triassic and Jurassic periods—the plants were shown by Stur[16] to match most closely those of the German Lettenkohle or lower Keuper, and more recently Dr. C. R. Eastman[17] has found the fish fauna to have its analogue in that of the upper Muschelkalk and the lower Keuper of the Alpine Province. In all of these discussions it has been taken for granted that the Newark is a geologic and paleontologic unit; and it must be admitted that little definite evidence to the contrary has as yet been obtained; but it seems incredible that the enormous thicknesses of beds developed here could all be represented by two or three hundred feet of the foreign Triassic. Mr. Lyman's plea for the more definite placing of fossil occurrences in the stratigraphic column is therefore worthy of more attention than it has received, for it is only by so doing that we can ever hope to learn the true relations and equivalences of the beds.

A geographical table of the more important fossil localities of Pennsylvania, exclusive of those of silicified wood, which were given

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[16] Die Lunzer-Lettenkohlen Flora in den "Older Mesozoic Beds of the Coal Field of Eastern Virginia," *Verh. KK. Geol. Reichsanst.*, 1888, pp. 203–217.

[17] Triassic Fishes of Connecticut, *Bull. Conn. Geol. Nat. Hist. Surv.*, No. 18, pp. 23–25, 1911.

in the preceding paper, is here introduced. The locality numbers correspond to those on the accompanying map.

B. *Bucks County.*

1. Wycombe: Quarries ½ mile south and 1 mile southwest of station. Upper part of the Gwynedd-Lockatong formation.
   Estheria ovata Lea.
   Other crustacea and fish scales.
2. Holicong: Mr. John S. Ash's farm, ¼ mile northwest of the cross-roads. For references see above. At least 3000 feet below the top of the Norristown-Stockton formation.
   Schizoneura sp.
   Cycadites sp. (cf. *tenuinervis* Fontaine).
3. Carversville: Road metal quarry ¼ mile to the east. A. P. Brown: New Cycads and Conifers from the Trias of Pennsylvania. *Proc. Acad. Nat. Sci. Phila.*, 1911, pp. 17–21, pl. I–V. Transition beds between the Norristown-Stockton and the Gwynedd-Lockatong formations.
   Podozamites formosus Brown.
   Zamites velderi Brown.
   Palissya diffusa (Emmons) Fontaine.
   " *obtusa* Brown.
   Cheirolepis munsteri Schenk.
   " *latus* Brown.

M. *Montgomery County.*

1. Gwynedd Tunnel, P. & R. Ry., north of Gwynedd Valley station. Cope: Synopsis of the Extinct Batrachia, Reptilia, and Aves of North America. *Trans. Amer. Phil. Soc.*, XIV, pp. 170–175, 1871. Also other references by Leidy and Lea in *Proc. Acad. Nat. Sci. Phila.*, 1859, etc. Middle of the Gwynedd-Lockatong formation, of which it is the type locality.
   Numerous bones of a pterosaur, *Rhabdopelix longispinis* Cope.
   Various fish scales and reptile teeth.
2. Arcola: Perkiomen R. R. cuts ¼ mile and ¾ mile southeast of station. Bottom of Gwynedd-Lockatong.
   Estheria ovata Lea.
   Fish scales.
3. Yerkes: Perkiomen R. R. cut near station. Leidy: Fish Remains of the Mesozoic Red Shales. *Proc. Acad. Nat. Sci. Phila.*, 1876, p. 81. Base of Brunswick.
   A few fish scales, *Radiolepis elegans* Emmons?.
4. Graters Ford: Fishers quarry, 1 mile northwest of station. Lower part of Brunswick. Fossil footprints, of several species.

C. *Chester County.*

1. Phœnixville: P. & R. Ry. tunnel ½ mile north of station. Has been the subject of numerous papers, the most elaborate of

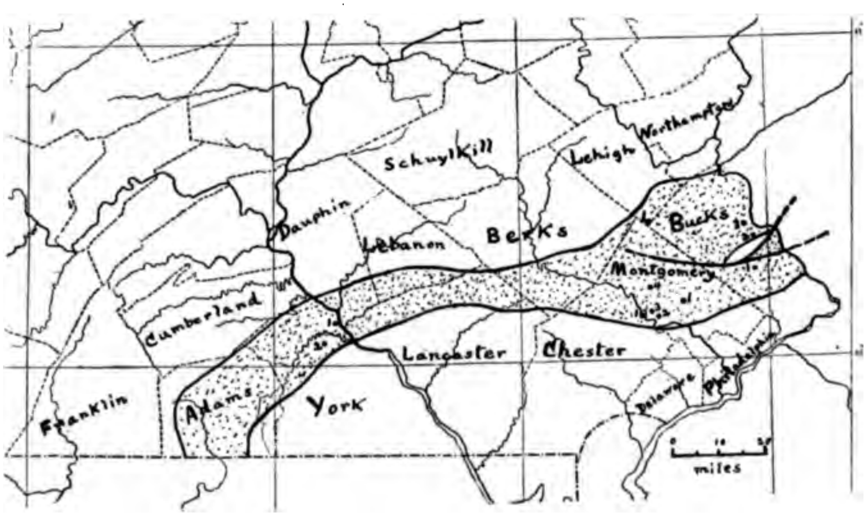
which is that of Wheatley: Remarks on the Mesozoic Red Sandstone of the Atlantic Slope, and Notice of the Discovery of a Bone Bed Therein. *Amer. Jour. Sci.*, [2], XXXII, pp. 41–48, 1861. Middle of Gwynedd-Lockatong formation.
Plants, species of *Equisetum*, *Pterozamites*, and *Ctenophyllum*.
Estheria ovata and other crustacea.
Fish scales.
Reptile teeth and bones.

L. *Lehigh County.*

1. Hosensack: Road cut somewhere southwest of the village. Lea: Description of a Fossil Saurian of the New Red Sandstone Formation of Pennsylvania; with some Account of that Formation. *Jour. Acad. Nat. Sci. Phila.*, [2], II, pp. 185–202, Pl. XVII–XVIV, 1854. Middle of the Brunswick.
Reptilian bones: *Clepysaurus pennsylvanicus* Lea.

Y. *York County.*

1. York Haven and vicinity. Wanner and Fontaine, in Ward's Status of the Mesozoic Floras of the U. S., *loc. cit.*, pp. 233–255, 1900. Middle of the Gwynedd-Lockatong.
Numerous fossil plants.
2. Emigsville: Copper prospects 2 miles northwest. Frazer and Cope: [Fossils from York County], *Proc. Amer. Phil. Soc.*, XXIII, pp. 403, 404, 1886.
Reptile bones and teeth.



Nearly all of these localities, as pointed out by Mr. Lyman, are in the Gwynedd-Lockatong formation. As this consists of a series of carbonaceous and calcareous rocks, no doubt representing a time

of swamp development, attributable to a temporary modification of climatic conditions, which would of course affect the whole region at the same time, the fossils from the various places could hardly be expected to be otherwise than equivalent. It is these that are used in correlation of the "Newark" with the European Keuper. The only fossil locality at any considerably lower horizon is that at Holicong, Bucks County (B. 2). The forms occurring there are unfortunately not specifically identifiable, and so can throw little light on the age of the beds. But since both *Cycadites* and *Schizoneura* are genera which are found in the Bunter or lower Triassic of Europe, it is by no means impossible that the Norristown-Stockton formation is really the approximate equivalent of that horizon, which it certainly closely resembles lithologically.

Because of the total absence of fossils of diagnostic value in the upper 10,000 feet of the Brunswick formation in Pennsylvania, its exact position is also indeterminate. It further does not seem advisable to attempt extrapolation into other districts, where the succession of formations is in general quite different from that here outlined. But the absence of beds of uppermost Triassic or even of Jurassic age can in no way be regarded as certain.

It is to be concluded, then, that there is no evidence whatever of the deposition of any part of the New Red or Newark group during the Permian period; but since all of the fossils of diagnostic value, indicating middle-upper Triassic age, have come from a rather limited horizon, about the middle of the group, we are not justified in concluding either that the whole group is of the same age or that the Bunter sandstone below and the upper Keuper or Rhætic above are not represented in the American rocks.

A CATALOGUE OF JAPANESE CEPHALOPODA.

BY S. STILLMAN BERRY.

INTRODUCTION.

While engaged in a somewhat comprehensive study of the Cephalopod fauna of the Hawaiian Islands, the writer found himself impelled to consider the possibility of correlation with that of other regions of the Pacific, notably Japan, whence so many bizarre and interesting types have been described. In pursuance of this a simple catalogue was first compiled, then a fairly detailed list of references added, and finally, when the collections of Stanford University proved to be surprisingly rich in material from this region, a mass of other data was accumulated. The greater part of all this is now offered in the present paper. The aim is merely to present a bibliographic catalogue of all the cephalopod mollusks known to occur within the waters of the Japanese Empire, with the addition of a few more or less pertinent notes regarding such species as have chanced to come under the personal observation of the writer.

As already indicated, the bulk of this material was furnished by the zoological collections of Stanford University, where it owes its origin chiefly to the Jordan and Snyder Expedition to Japan in 1900. As the purpose of this expedition was mainly ichthyological, no special effort was made to secure a large collection of cephalopods, but the species which were incidentally obtained are fairly numerous and frequently of considerable interest.

In addition to the above, mention should be made of a small series of cephalopods secured by Dr. David Starr Jordan at Fusan, Korea, in 1911, and a few taken at Takao, Formosa, by Mr. Hans Sauter, which are likewise in the Stanford University collections.

Through the courtesy of Mr. Samuel Henshaw, I have also had the privilege of examining a large series of *Euprymna* from Hong Kong in the Museum of Comparative Zoology.

Lastly, but very fortunately, I have been enabled, through the signal kindness of Prof. A. E. Verrill, to secure the loan of an inextensive but unusually interesting series of small squids, including cotypes of two important species, taken many years ago by Prof.

E. S. Morse in the Bay of Tokio (Yeddo), and now preserved in the Yale University Museum.

Historical Survey.

With the possible exception of Tilesius, the honor of being the first author who attempts to refer taxonomically to any Japanese cephalopod belongs, so far as I have been able to ascertain, to Alcide d'Orbigny, who, in the great *Histoire* produced during the years 1834–1839 in collaboration with Férussac, attributed the following-named forms to this region:

Octopus Fang-siao.	*Sepiola japonica.*
Octopus areolatus.	*Sepioteuthis sinensis.*
Octopus sinensis.	*Sepia sinensis.*
Loligopsis chrysophtalmos.	

As the majority of these nominal species were based upon the rude drawings or descriptions of other authors and hence, as a rule, are quite unaccompanied by accurate definition, only the *Octopus areolatus* appears capable of precise determination. All of the other names, with the doubtful exception of *Sepiola japonica*, have dropped from use.

Following the activity of d'Orbigny, we find a long period covering the decades from 1845 to 1885 when but little in regard to this particular field found its way into print save a few exceedingly scattered and fragmentary observations by such authors as Lischke (1869), Tryon (1879), Steenstrup (*Sepia andreana* 1875, *Todarodes pacificus* 1880), Hilgendorf (*Architeuthis martensii* 1880), Owen (1881), and Verrill (*Inioteuthis japonica* and *morsei* 1881).

In the years 1885 and 1886, however, occurred the successive publication by Dr. William E. Hoyle of the important results attained by his exhaustive study of the cephalopods taken during the cruise of H. M. S. "Challenger." In a résumé of the Cephalopoda of the region under consideration (1886, p. 219) some 25 species (one of them doubtful and another since eliminated) belonging to 8 genera are listed. The species added to the fauna include the type of a new genus, 8 other new forms, and several others previously described from other regions, as follows:

Octopus hongkongensis.	*Sepia myrsus* ?
Octopus januarii.	*Sepia esculenta.*
Promachoteuthis megaptera.	*Sepia kobiensis.*
Loligo edulis.	*Sepia andreanoides.*
Loligo kobiensis.	*Sepiella maindroni.*
Loligo japonica.	*Calliteuthis ocellata* (as *C. reversa*).

In the meanwhile appeared an important paper by Appellöf (Japanska Cephalopoder, Stockholm, 1886), which is significant as being the first time that we find the cephalopods of Japan dealt with as an assembled unit by themselves. In this paper 8 species were added:

Octopus vulgaris.	*Loligo bleekeri.*
Octopus globosus n. s.	*Loligo sumatrensis.*
Octopus macropus.	*Sepia peterseni* n. s.
Sepioteuthis lessoniana.	*Sepia* (=*Metasepia*) *tullbergi* n. s.

Two years later the publication of a second treatise on the same subject from the pen of Dr. A. E. Ortmann (Japanische Cephalopoden, *Zool. Jahrb.*, 1888) marked another notable increase in our knowledge. Thirty-six species referable to 10 genera are accredited to our area, of which the following are first recorded:

Tremoctopus doderleini n. s. (=*Ocythoe tuberculata*)	*Loligo tetradynamia* n. s.
Octopus kagoshimensis n. s.	*Loligo chinensis.*
Octopus pusillus.	*Loligo aspera* n. s.
Microteuthis paradoxa n. s. (=*Idiosepius*).	*Sepia hoylei* n. s.
	Sepia torosa n. s.
	Sepia tokioensis n. s.

During the next twenty years succeeded another period of only occasional short papers and desultory notes, the most important of which are those of Pilsbry (*Sepia hercules*, 1894), Ijima and Ikeda (*Opisthoteuthis depressa* 1895, *Amphitretus pelagicus* and *Alloposus pacificus* 1902), Mitsukuri and Ikeda (1898), Joubin (1897, 1898), Pfeffer (1900), Nishikawa (1906), Meyer (1906), and Chun (1908, 1910).

Very recently Wülker (1910) has published a third survey of the Japanese members of the group, based upon a portion of the valuable material brought to Germany by Dr. Döflein. In this work, notable for its numerous interesting data and the able manner in which they are presented, Japan is accredited with no less than 24 genera comprising an even 60 species (3 of them doubtful). The following are additions to the fauna:

Tremoctopus violaceus.	*Sepia elliptica.*
Polypus döfleini n. s.	*Sepia lorigera* n. s.
Polypus pictus fasciatus.	*Sepia misakiensis* n. s.
Sepia aculeata.	*Sepia appellofi* n. s.

Symplectoteuthis oualaniensis.

In the present catalogue the recognized number is increased to 67 species (4 considered doubtful), falling under 29 genera, with

one somewhat doubtful subspecies. But one new species (*Sepia formosana*) is here proposed, although two others, *Stoloteuthis nipponensis* and *Abraliopsis scintillans* (Berry 1911, 1911*a*), have previously been described from the same material and are now more fully characterized and figured.

Relationships and Distribution.

After the excellent discussion of the relationships of the Japanese cephalopod fauna by Wülker (1910, pp. 23, 24), it would be idle to reënter into the subject with much detail here. Suffice to say that the close analogy there dwelt upon between many Japanese and Mediterranean types is now still further heightened by the addition of *Thelidioteuthis alessandrinii* to the list. Nevertheless, the predominant tone of the fauna is quite decidedly Indo-Malayan. Indeed, outside of the genera *Loligo* and *Sepia*, astonishingly few species are known to be exclusively Japanese, though these two groups here attain such an abundant development and comprise so many unique species that the gross aspect of any large collection from the region is quite characteristic. The presence of the *hongkongensis* group of *Polypi* appears somewhat anomalous and may indicate that these species are invaders from the Aleutian-Californian fauna, where they or their near allies form one of the most striking elements, a conclusion which is, however, by no means to be regarded as certain.

These points are brought out somewhat more forcibly by statement in tabular form.

The distribution of the fauna, according to groups, is significantly shown in the following table:

	Genera.	Species.	Sub-species.	Doubtful.
OCTOPODA	7	20	1 ?	2
MYOPSIDA	11	35	.. .	2
ŒGOPSIDA	11	12	......	......
TETRABRANCHIATA	1	1	......	......
Total	30	68	1 ?	4

The most striking feature is very obviously the great preponderance of the Myopsida which comprise more species, or at least as many, as all other groups combined. This again is almost entirely due to the more abundant representation of *Loligo* and *Sepia*, and is quite the reverse of the conditions prevailing in other areas of the North Pacific.

Despite the enormous number of recognized species and the fact that no other region of the Pacific has been so diligently investigated, our understanding of the fauna is still so incomplete that this catalogue can scarcely be regarded as any less provisional in nature than its predecessors.

As yet we know almost nothing regarding the distribution of this class of animals along the coasts of northwestern Japan and in the Japan Sea, and but little collecting has been done anywhere on the island of Hokkaido. As is to be expected, the neighboring bays of Tokio, Sagami, and Suruga afford us with the bulk of our information, and the vicinity of Misaki has proven a particularly prolific locality.

NOTE.—In the following pages the sign ! indicates that specimens from the locality cited have been examined and verified by the present author. Numbers enclosed in brackets have reference to the private card register of the author and are given for purposes of convenience and accuracy only. Mere listing of a species in the various catalogues of Hoyle (1886, 1886*a*, 1897, 1909) and of Wülker (1910) has not generally been included in the lists of references.

Class **CEPHALOPODA.**

Order **DIBRANCHIATA** Owen, 1832.

Sub-order OCTOPODA Leach, 1818.

Family **CIRROTEUTHIDÆ** Keferstein, 1866.

Genus **OPISTHOTEUTHIS** Verrill, 1883.

Opisthoteuthis depressa Ijima and Ikeda, 1895.

Opisthoteuthis depressa Ijima and Ikeda, 1895, pp. 1–15, pl. 33.
Opisthoteuthis depressa Meyer, 1906, pp. 758–760 (anatomy).
Opisthoteuthis depressa Meyer, 1906*a*, pp. 183–269 [1–93], pls. 11–16 (anatomy).
Opisthoteuthis depressa Döflein, 1906, p. 260, fig.
Opisthoteuthis depressa Marchand, 1907, p. 381, [77] (anatomy).
Opisthoteuthis depressa Dollo, 1912, pp. 131, etc., pl. 3, fig. 5.

Distribution.—250 fathoms, Okinose Bank, near Misaki, Sagami (type locality).

Family **ARGONAUTIDÆ** Cantraine, 1840.

Sub-family ARGONAUTINÆ s. s.

Genus **ARGONAUTA** Linné, 1758.

The Japanese members of this genus have not yet been carefully worked out, but all three of the names appearing in the literature belong to widely distributed species.

Argonauta argo Linné, 1758.

Argonauta Argo Linné, 1758, p. 708, Nos. 282, 231.
Argonauta Argo Lischke, 1869, vol. I, p. 29 (locality record).
Argonauta Argo Dunker, 1882, p. 1 (mere note).
Argonauta argo Ortmann, 1888, p. 641.
Argonauta argo Jatta, 1896, p. 191, pl. 8, fig. 3; pl. 18, figs. 15–29.
Argonauta Argo Hirase, 1907, p. 3 (locality record).

Because of the large number of other species common to both regions, the identity of the Japanese race with typical *A. argo* from the Mediterranean is here assumed, although the fact still remains to be definitely established.

Distribution.—Enoshima, Sagami (Ortmann); Tokio (Dunker); Tango (Hirase); Loo-Choo Islands (Lischke). Atlantic, Mediterranean, and Indian Oceans.

Argonauta hians Solander, 1786.

Argonauta hians Solander, 1786, p. 44, No. 1,055 (*fide* Dall).
Argonauta hians Dillwyn, 1817, vol. 1, p. 334.
Argonauta gondola Dillwyn, 1817, vol. 1, p. 335.
Argonauta gondola Lischke, 1869, vol. I, p. 29 (mere note).
Argonauta gondola Dunker, 1882, p. 1 (mere note).
Argonauta hians Ortmann, 1888, p. 641.

Distribution.—Enoshima, Sagami (Ortmann); Sagami (Hirase); Loo-Choo Islands (Lischke). Indo-Pacific, South Atlantic, etc.

Argonauta hians navicula Solander, 1786.

Argonauta navicula Solander, 1786, p. 44, No. 1,055 (*fide* Dall).
Argonauta Oweni Adams and Reeve, 1850, p. 4, pl. 3, figs. 1*a*–1*d*.
Argonauta Owenii Dunker, 1882, p. 1 (mere note).
Argonauta hians navicula Dall, 1908, pp. 226, 229.

Distribution.—Japan (Dunker). South Atlantic, Indo-Pacific, etc.

Sub-family OCYTHOINÆ.

Genus **OCYTHOE** Rafinesque, 1814.

Ocythoe tuberculata Rafinesque, 1814.

Ocythoe tuberculata Rafinesque, 1814, p. 29.
Tremoctopus döderleini Ortmann, 1888, p. 642, pl. 20.
Ocythoe tuberculata Jatta, 1896, p. 198, pl. 6, fig. 3; pl. 7, fig. 8; pl. 19, figs. 1–12; text figs. 14, 52.
Ocythoe tuberculata Wülker, 1910, p. 4.

The *Tremoctopus döderleini* of Ortmann, which is obviously not a *Tremoctopus* in the accepted sense of the term, is said by Wülker to be identical with the common Mediterranean *O. tuberculata*. The reported dispersal of the species is somewhat peculiar and indicates that it will eventually prove to be nearly cosmopolitan.

Distribution.—Bay of Tokio (Ortmann); near Misaki, Sagami (Wülker); near Aburatsubo, Sagami (Wülker). Mediterranean Sea; Vineyard Sound, Massachusetts (Verrill); West Indies (*fide* Verrill).

Sub-family TREMOCTOPODINÆ.

Genus **TREMOCTOPUS** Delle Chiaje, 1829.

Tremoctopus violaceus Delle Chiaje, 1829.

Tremoctopus violaceus Delle Chiaje, 1829, pls. 70, 71 (*fide* Wülker).
Tremoctopus violaceus Jatta, 1896, p. 204, pl. 6, fig. 2; pl. 20, figs. 1–18.
Tremoctopus violaceus Wülker, 1910, p. 5.

Distribution.—Coast of Boshu, Sagami Sea (Wülker). Mediterranean Sea.

Family **POLYPODIDÆ** Hoyle, 1904.

Genus **POLYPUS** Schneider, 1784.

That the genus *Polypus* attains an especially large development on the coasts of Japan is attested by the formidable list of names which have at one time or another been ascribed to this area, and that despite the fact that, so far as members of this group are concerned, the deeper waters off shore are still practically a *terra incognita*, *P. januarii* being the only abyssal species thus far reported. However, the true number belonging to the fauna is somewhat obscured by the lack of sufficient diagnosis or other needful information respecting several of the alleged species. The following list is thought to include all the names which occur in the literature:

Polypus vulgaris Lamarck.
P. granulatus Lamarck (=*rugosus* Bosc.).
P. macropus Risso (=*cuvieri* d'Orbigny).
P. kagoshimensis Ortmann.
P. globosus Appellöf.
P. pusillus Gould.
P. januarii Steenstrup.
P. hongkongensis Hoyle.
P. döfleini Wülker.
P. pictus fasciatus Hoyle.
P. areolatus De Haan.
P. ocellatus Gray.
P. brocki Ortmann.
P. fang-siao d'Orbigny.[1]
P. sinensis d'Orbigny.[1]
P. membranaceus Quoy and Gaimard.

Polypus vulgaris (Lamarck, 1799).

Octopus vulgaris Lamarck, 1799, p. 18 (*fide* Jatta).
Octopus octopodia Tryon, 1879, p. 113, pl. 23, figs. 3, 4 (after d'Orbigny); pl. 24, figs. 5, 6 (after d'Orbigny); pl. 24, fig. 7 (after Jeffreys).
Octopus vulgaris Appellöf, 1886, p. 7.
Octopus vulgaris Ortmann, 1888, p. 642.
Polypus vulgaris Wülker, 1910, p. 5.

As I have had no European specimens of *P. vulgaris* available for comparison, I cannot feel personally certain that the following specimens are correctly referred to this species, but I think little doubt exists that they are conspecific with the form so identified

[1] *Octopus Fang-siao* and *Octopus sinensis* are names applied by d'Orbigny to certain rude illustrations of Chinese or Japanese origin and published by him without any real diagnosis. They are nearly or quite unrecognizable and probably can never have any standing. Appellöf has suggested that *O. Fang-siao* belongs to the synonymy of *O. ocellatus*. Tryon refers *O. sinensis* without hesitation to *O. membranaceus*, Hoyle somewhat dubiously unites it with *O. areolatus*, while Appellöf places it with a query under *O. vulgaris*.

by the various other writers on Japanese cephalopods. The fact that the lateral arms are usually notably longer than the others, the minute conical hectocotylus, reticulate surface, and reddish-gray color seem to be very characteristic. The lateral arms in the male show a conspicuous enlargement of one or (occasionally) more of the suckers near the umbrella margin, as has been noted in numerous other species.

The dimensions of two ♂ specimens are given below:

	[No. 339] mm.	[No. 337] mm.
Total length to tip of arms	610[2]	355[2]
Length of mantle (dorsal)	101	71
Width of mantle	85	60
Width of neck	47	39
Width of head	53	40
Length of funnel	45	33
Length of right dorsal arm, outside measurement	395[2]	220[2]
Length of left dorsal arm, outside measurement	410[2]	200[2]
Length of right second arm, outside measurement	470+[2]	265[2]
Length of left second arm, outside measurement	440[2]	245[2]
Length of right third arm, outside measurement	380[2]	205[2]
Length of left third arm, outside measurement	420[2]	250[2]
Length of right ventral arm, outside measurement	380[2]	230[2]
Length of left ventral arm, outside measurement	380[2]	225[2]
Length of hectocotylus	4	3
Length of umbrella between dorsal arms	55	50
Length of umbrella between ventral arms	70	35
Diameter of largest sucker	20	13

Material Examined.—

No. Sp.	Locality.	Sex.	Collectors.	Where deposited.	Author's Register.
1	Misaki, Sagami	♂	Jordan and Snyder	L.S.J.U., Cat. 2,000	336
1	Misaki, Sagami	♀	Jordan and Snyder	L.S.J.U., Cat. 2,001	345
1	Bay of Waka, Kii	♀	Jordan and Snyder	L.S.J.U., Cat. 2,002	335
3	Tsuruga, Echizen	♀	Jordan and Snyder	L.S.J.U., Cat. 2,004	338
1	Tsuruga, Echizen	♂	Jordan and Snyder	L.S.J.U., Cat. 2,003	339
3	Tsuruga, Echizen	2♂ 1♀	Jordan and Snyder	Not retained	340
2	Fusan, Korea	♂	D. S. Jordan	L.S.J.U., Cat. 2,005	337
1	Fusan, Korea	♀	D. S. Jordan	L.S.J.U., Cat. 2,006	334

[2] Measurements necessarily inaccurate.

Distribution.—Bay of Tokio (Ortmann); Misaki, Sagami ! (Wülker); Nagasaki (Appellöf); Bay of Waka, Kii (!); Tsuruga, Echizen (!); Fusan, Korea (!). Nearly cosmopolitan in the Atlantic, Mediterranean, and Indian Oceans.

Polypus granulatus (Lamarck, 1799).

Sepia rugosa Bosc., 1792, p. 24, pl. 5, figs. 1, 2 (*fide* Hoyle).
Octopus granulatus Lamarck, 1799, p. 20.
Octopus rugosus Brock, 1887, p. 605.
? *Octopus kagoshimensis* Ortmann, 1888, p. 644, pl. 21, fig. 2.
Octopus rugosus Ortmann, 1891, p. 669.
Octopus granulatus Joubin, 1897*a*, p. 99.
Polypus granulatus Wülker, 1910, p. 5.

An almost cosmopolitan species characterized by its short, sub-equal arms, only about double the length of the body (Brock), and usually having the formula 4, 3, 2, 1; the warted surface (apparently a very variable feature), coloration, etc. I have not discovered this form in any of the material at my disposal.

Distribution.—Washinokami, Rikuzen (Wülker); Misaki, Sagami (Wülker); Nagasaki, Hizen (Joubin). Atlantic, Indo-Pacific, etc.

[**Polypus kagoshimensis** (Ortmann, 1888).]

Octopus kagoshimensis Ortmann, 1888, p. 664, pl. 21, fig. 2.
Octopus rugosus (pars) Ortmann, 1891, p. 669.
Polypus granulatus (pars ?) Wülker, 1910, p. 6.

Three years after its description this species was referred by Ortmann himself to *O. rugosus* Bosc. (*granulatus*), and the same course has been somewhat doubtfully followed by Wülker.

Distribution.—Kagoshima (type locality, Ortmann).

Polypus globosus (Appellöf, 1886).

Octopus globosus Appellöf, 1886, p. 7, pl. 1, figs. 4, 5.
Octopus globosus Ortmann, 1888, p. 662.
Octopus rugosus (pars) Ortmann, 1891, p. 669.
Octopus globosus Goodrich, 1896, p. 19, pl. 5, fig. 81 (hectocotylus).
Octopus globosus Joubin, 1897*a*, p. 98.
Octopus globosus Appellöf, 1898, p. 565.
Polypus globosus Hoyle, 1909, p. 259 (no description).

This is a rather small species belonging to the same group as *P. granulatus* and *P. kagoshimensis*. It has been united with *P. rugosus* (*granulatus*) by Ortmann, but this disposition has since been vigorously combated by Appellöf.

Distribution.—Nagasaki, Hizen (Appellöf). Ternate (Appellöf); Straits of Malacca (Goodrich); Kabusa Is. (Goodrich); Nicobar Is. (Goodrich); Bombay (Goodrich); Point Galle, Ceylon (Goodrich).

Polypus pusillus (Gould, 1852).

Octopus pusillus Gould, 1852, p. 478, fig. 591.
Octopus pusillus Tryon, 1879, p. 112, pl. 31, figs. 31–33.
Octopus pusillus Ortmann, 1888, p. 644, pl. 21, fig. 1.
? *Polypus pusillus* Hoyle, 1904, p. 16, pl. 4, fig. 5.

The identity and important characters of this species are scarcely yet established upon a firm basis, for it seems to me questionable whether the Western Pacific specimens referred by Hoyle (1904) to *P. pusillus* are really conspecific with Gould's type. The relatively wide umbrella (one fourth as long as the arms) arm formula 1, 2, 3, 4, lack of cirri, smooth skin, and large, prominent eyes appear to be the most salient features noted in Gould's description.

Distribution.—Kagoshima, Satsuma (Ortmann). Mangsi Islands, China Sea (type locality, Gould); off the southwest coast of Central America (Hoyle).

Polypus macropus (Risso, 1826).

Octopus macropus Risso, 1826, vol. 4, p. 3 (*fide* Hoyle).
Octopus Cuvierii d'Orbigny, in d'Orbigny and Férussac, 1826, Poulpes, pl. 4 (*fide* Hoyle).
Octopus Cuvieri Appellöf, 1886, p. 6, pl. 1, fig. 6.
Octopus macropus Hoyle, 1886, pp. 11, 95.
Octopus macropus Ortmann, 1888, p. 643, pl. 21, fig. 3 (hectocotylus).
Octopus macropus Joubin, 1897*a*, p. 99.
Polypus macropus Wülker, 1910, p. 8.

The loose, soft, elongate body; long, attenuate, and very unequal arms; short umbrella; curiously formed hectocotylus, and nearly smooth surface serve to distinguish *P. macropus* from any of its Japanese congeners. The arms of the various pairs are conspicuously different in proportion, their order persistently 1, 2, 3, 4, and the dorsal pair much the stoutest and longest. The right third arm of the ♂ is scarcely half as long as its mate of the opposite side and terminates in an extremely conspicuous, oblong, trough-shaped hectocotylus, ornamented with perhaps 8 or 9 prominent transverse ridges on its inner surface and so thickened as to greatly exceed the adjacent portion of the arm in diameter.

The skin is in general smooth, but the present material shows usually about three small conical tubercles just above and behind each eye-opening, with a few scattered smaller ones occasionally apparent over the rest of the dorsum.

The more important measurements of two specimens are given below, both being males:

	No. 327. mm.	No. 325. mm.
Length, total	225	320
Length of mantle, dorsal	75	45
Width of mantle	30	29
Width of neck	13	15
Width of head	21	20
Length of funnel	41	30
Length of right dorsal arm (outside measurement)	390	140+
Length of left dorsal arm (outside measurement)	435	255
Length of right second arm (outside measurement)	300+	195
Length of left second arm (outside measurement)	305	190+
Length of right third arm (outside measurement)	140	90
Length of left third arm (outside measurement)	245	170
Length of right ventral arm (outside measurement)	175+	156
Length of left ventral arm (outside measurement)	215	152
Length of hectocotylus	20	9
Width of hectocotylus	7	3.5
Width of umbrella between dorsal arms	65	34
Width of umbrella between ventral arms	30	26

Distribution.—Hakodate, Oshima (!); Aomori, Mutsu (!); Matsushima, Rikuzen (!); Bay of Tokio (Ortmann); Misaki, Sagami (Wülker !); Yokohama (Hoyle); Bay of Waka, Kii (!); Nagasaki, Hizen (Appellöf).

Canary Islands, Mediterranean Sea, etc. As this species has also been recorded from the Red Sea, Bay of Bengal, Straits of Malacca, and various other localities, its area of distribution appears to form a continuous belt along the entire southern and southwestern shores of the Eurasian continent. It is represented in the Stanford University collections by an excellent series of specimens from the following localities:

No. Sp.	Locality.	Sex.	Collectors.	Where deposited.	Author's Register.
1	Hakodate, Oshima	♂	Jordan and Snyder	L.S.J.U., Cat. 2,007	328
2	Aomori, Mutsu	♂	Jordan and Snyder	L.S.J.U., Cat. 2,008	325
3	Matsushima, Rikuzen	♀ 2♂	Jordan and Snyder	L.S.J.U., Cat. 2,009	327
?1	Misaki, Sagami	♀	Jordan and Snyder	L.S.J.U., Cat. 2,011	346
1	Bay of Waka, Kii	♀	Jordan and Snyder	L.S.J.U., Cat. 2,010	326

Polypus hongkongensis (Hoyle, 1885).

? *Octopus punctatus* Gabb, 1862, p. 170 (not of Blainville, 1826).
Octopus hongkongensis Hoyle, 1885*a*, p. 224.
Octopus hongkongensis Hoyle, 1885*c*, p. 99.
Octopus punctatus Hoyle, 1886, pp. 11, 100, etc., pl. 5.
Octopus punctatus Ortmann, 1888, p. 662.
Octopus punctatus Joubin, 1897, p. 110, pl. 9.
Octopus punctatus Joubin, 1897*a*, p. 98.
Polypus punctatus Wülker, 1910, p. 7.

Wülker cites the enormous elongate hectocotylus ($\frac{1}{9}$ or more the length of the arm) and the very long arms (7 times the ventral mantle length) as perhaps the most conspicuous features which may be depended upon to distinguish this very distinct species. I am not at all convinced that the Eastern Asiatic species is really identical with the *O. punctatus* Gabb of California, although without doubt they are very closely related.

Distribution.—345 fathoms, off Ino Sima Island (type locality, Hoyle); Aburatsubo, Sagami (Wülker). Hong Kong, China (Hoyle); Kamtschatka (Joubin).

Polypus döfleini Wülker, 1910.

Polypus döfleini Wülker, 1910, p. 7, pl. 2, figs. 1, 2; pl. 3, fig. 10.

A species of the *hongkongensis* group distinguished by its relatively moderate arms (4 times the ventral mantle length) and decidedly smaller hectocotylus (one-sixteenth as long as the arm).

Distribution.—Todohokke, Oshima (type locality, Wülker).

Polypus sp. Young.

Catalogue No. 2,012, Stanford University Invertebrate Series, contains four small ♂ *Polypi* taken by Snyder and Sindo at Tanegashima Island, Japan [S. S. B. No. 344]. These agree briefly in the following characters, but I am unable to refer them with certainty to any of the described species:

Body plump, firm, rounded; head short and broad. Dorsal surface finely and quite evenly granulose with numerous minute, acute, pointed papillæ; one or two larger ones over each eye; smooth below.

Arms moderate, subequal, evenly tapering, about three times as long as the head and body, their order 3 = 2, 4, 1. Suckers large, crowded; one or two of those just inside the web margin on the lateral arms a little larger than the rest, but not abruptly or conspicuously so. Hectocotylized arm scarcely at all shorter than its mate of the opposite side; the terminal organ very small, smooth, elongate, spoon-shaped. Umbrella short, about equally developed all around.

Color a dark blackish slate, paler below and within the arms.

Measurements.

	mm.	mm.	mm.
Total length	106	85	78
Length of mantle (dorsal)	18	15	15
Width of mantle	20	15	14
Width of neck	14	11.5	10.5
Width of head	15	14	13
Length of funnel	10	9	6
Length of right dorsal arm	70	56	50
Length of left dorsal arm	71	55	49
Length of right second arm	75+	64	54
Length of left second arm	83	65	54
Length of right third arm	78	65	60
Length of left third arm	84	65	60
Length of right ventral arm	75	58+	58
Length of left ventral arm	75	58	61
Length of hectocotylus	3	3	3
Length of umbrella between dorsal arms	14	14	8
Length of umbrella between ventral arms	11	12	8

These specimens in certain ways suggest the *P. globosus* of Appellöf, but the order of the arms is decidedly different, and the hectocotylus, though very much smaller, is of a similar type to that prevailing in the *hongkongensis* group. The possibility has not been overlooked that they may be young *P. döfleini*, but here again the arm formulæ fail to coincide.

Polypus januarii (Steenstrup, 1885).

Octopus januarii "Steenstrup, MS.," Hoyle, 1885*a*, p. 229.
Octopus januarii "Steenstrup, MS.," Hoyle, 1885*c*, p. 105.
Octopus januarii Hoyle, 1886, pp. 11, 76, 97, etc., pl. 7, fig. 4.
Octopus Januarii Goodrich, 1896, p. 19.
Polypus januarii Hoyle, 1904, p. 18, pl. 5, fig. 2 (radula).

A very distinct species, well differentiated from all other Japanese *Polypi* by its soft, smooth integument, pinkish color, swollen eyes, extensive umbrella, short conical hectocotylus, and abyssal habit. It has been taken in this region only by the "Challenger," which secured a single ♂ specimen at a depth of 1875 fathoms in the North Pacific east of Japan (Hoyle, 1886).

Distribution.—North Pacific, east of Japan (Hoyle). Off Barra Grande, Brazil (type locality, Hoyle); Rio de Janeiro, Brazil (Hoyle); Bay of Bengal (Goodrich); Andaman Sea (Goodrich); off the Cocos Islands (Hoyle).

Polypus pictus fasciatus (Hoyle, 1886).

Octopus pictus var. *fasciata* Hoyle, 1886, p. 94, pl. 8, fig. 3.
Octopus pictus var. *fasciata* Goodrich, 1896, p. 19, pl. 5, fig. 82 (hectocotylus).
Polypus pictus var. *fasciata* Wülker, 1910, p. 6.

Characterized by its conspicuous and definite color pattern comprising various bands of pigment on the body and series of roundish blotches along the outer surfaces of the arms.

Distribution.—Aburatsubo, Sagami (Wülker). Port Jackson, Australia (type locality, Hoyle, Goodrich).

Polypus ocellatus (Gray, 1849).

Octopus ocellatus d'Orbigny, in d'Orbigny and Férussac, Poulpes, pl. 9, upper fig. (*fide* Gray).
Octopus ocellatus Gray, 1849, p. 15.
Octopus membranaceus Tryon (*pars*), 1879, p. 285 (merely listed), pl. 29, fig. 8.
Octopus ocellatus Appellöf, 1886, p. 8, pl. 1, figs. 1–3.
Octopus areolatus Hoyle (pars), 1886, pp. 8, 86.
Octopus ocellatus Brock, 1887, pp. 608, 611.
Octopus ocellatus Ortmann, 1888, p. 662 (mere note).
Octopus ocellatus Joubin, 1898, p. 22.

The status of this species is still very uncertain as it is not quite apparent whether the *Octopus ocellatus* Gray is the same as the Chinese drawing to which the same name was previously applied by d'Orbigny, or whether the *O. ocellatus* Appellöf is in turn identical with that of Gray. Tryon refers Gray's species to *O. membranaceus*, while Hoyle places *O. ocellatus* of both Gray and Appellöf in the synonymy of *O. areolatus*. However, Appellöf's determination has been called in question by Brock.

Wülker, the most recent writer on the subject, lists the species as *P. ocellatus* Gray.

Distribution.—Nagasaki, Hizen (Appellöf); China Sea (type locality, Gray).

Polypus areolatus (de Haan, 1838).

Octopus areolatus de Haan MS., 1835 (*fide* d'Orbigny).
Octopus areolatus d'Orbigny, in d'Orbigny and Férussac, 1838, p. 65.
? *Octopus sinensis* d'Orbigny, in d'Orbigny and Férussac, 1838, p. 68, pl. 9.
Octopus areolatus d'Orbigny, 1845, p. 186.
? *Octopus ocellatus* Gray, 1849, p. 15.
Octopus areolatus Hoyle, 1886, pp. 8, 86, 205, etc., pl. 3, figs. 6, 7.
Octopus areolatus Brock, 1887, pp. 610, 611.
Octopus brocki Ortman, 1888, p. 645.
Octopus areolatus Ortmann, 1888, p. 662.
Octopus areolatus Joubin, 1894, p. 28.
Octopus areolatus Joubin, 1898, p. 22.
Polypus areolatus Hoyle, 1904, p. 16.
Polypus areolatus Wülker, 1910, p. 6.

P. areolatus is a small species with a compact, pyriform body, widest posteriorly, and with a conspicuous ventral furrow. The head is small and weakly differentiated from the body. The dorsal

surface is quite heavily and evenly papillose with either (1) soft polygonal tubercles, or (2) almost a shagreen of small stellate warts, or (3) fairly smooth when poorly preserved. Ventrally the papillæ become nearly obsolete. A group of two large and several smaller papillæ surmounts either eye.

The arms are almost of a length, the second pair slightly longer than the others, but not much more than twice as long as the head and body taken together. They taper evenly to slender extremities. In the male the third right arm is only a little shorter than its mate. The very ample marginal canal is transversely striate within and terminates in a faint groove running down the inner face of the small naked elongate-conical hectocotylus. One sucker of the fifth or sixth pairs on each lateral arm shows a conspicuous enlargement.

The color of preserved specimens is a dark slaty-brown, paler below and on the inner surface of the umbrella. Obliquely in front

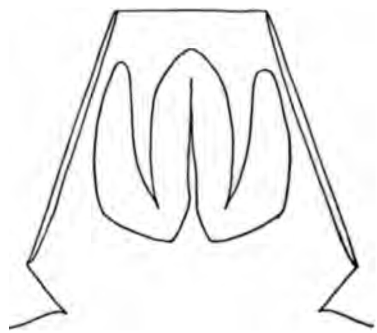


Fig. 1.—*Polypus areolatus*, outline drawing of funnel organ, × 2; [148].

of and below the eye on either side is a conspicuous eye-like spot, comprising a dark outer ring enclosing within it a narrower ring of a lighter color (usually bluish and showing a faint metallic lustre), and within this a central zone of the same dark shade as the outer ring. There is also a definable but less conspicuous ovoid spot between the eyes of a lighter and browner tint than the general surface. The ocular markings of the six specimens in the Stanford University collection seem much larger than those of the animal figured by Hoyle in the Challenger Report, but I have no doubt but that they are correctly referred to the same species.

The measurements of a well-preserved male are given below, the specimen referred to being No. 148 of the author's register.

	mm.
Total length	203
Length of body (dorsal)	42
Width of body	35
Width of neck	20
Width of head	21
Length of funnel	20
Length of right dorsal arm (inside measurement)	134
Length of left dorsal arm (inside measurement)	130
Length of right second arm (inside measurement)	85+
Length of left second arm (inside measurement)	142
Length of right third arm (inside measurement)	120
Length of left third arm (inside measurement)	121+
Length of right ventral arm (inside measurement)	125
Length of left ventral arm (inside measurement)	120+
Length of hectocotylus	7
Length of umbrella between dorsal arms	28
Length of umbrella between ventral arms	24
Dimensions of ocular spot of right side	7 x 12

Ortmann separates his *P. brocki* from *P. areolatus* on account of (1) the larger ocular spots; (2) the nearly smooth skin; (3) the unusual enlargement of the suckers, and (4) the presence of a brown spot between the eyes. Wülker considers part of these characters due to the preservation and suggests that the remainder are equally applicable to *P. areolatus*. The present specimens bear out this opinion very fairly.

Distribution.—Aomori, Mutsu (!); Tsuruga, Echizen (!); Tokio (!); 100 meters off Misaki, Sagami (Wülker); 110 meters off Dzushi, Sagami (Wülker); Bay of Waka, Kii (!); Kagoshima, Satsuma (Ortmann). Hong Kong (Hoyle); south of Papua (Hoyle).

Material Examined.—

No. Sp.	Locality.	Sex.	Collectors.	Where deposited.	Author's Register.
2	Aomori, Mutsu	♂	Jordan and Snyder	L.S.J.U., Cat. 2,013	329
1	Tsuruga, Echizen	♂	Jordan and Snyder	L.S.J.U., Cat. 2,014	148
1	Tokio	♂	Jordan and Snyder	L.S.J.U., Cat. 2,015	347
1	Bay of Waka, Kii	♀	Jordan and Snyder	L.S.J.U., Cat. 2,017	330

A specimen entered as L. S. J. U., Cat. 2,018 (S. S. B. No. 332], collected by Jordan and Snyder at Tsuruga, Echizen, is not only much larger than any of the specimens above referred to *P. areolatus*,

but differs from them so conspicuously in several quite important characters that I feel considerable uncertainty as to whether it is specifically identical with them.

There is a large irregular tubercle over each eye, but except for this the skin is almost perfectly smooth. At various points on the dorsal surface, however, are to be observed a few small scattered pit-like indentations resembling impressed papillæ, most conspicuous being a diamond-shaped group of four on the middle of the back. The arms are about three and a half times as long as the head and body and very unequal, though this appears to be due to the fact that many of them have been mutilated and are undergoing regeneration. The enlarged suckers and hectocotylus are similar to those just described for *P. areolatus.* The color is exceedingly dark and the heavy pigmentation extends over even the inner surfaces of the arms and periphery of the suckers, so that the pale inner surfaces of the latter stand out very conspicuously against the slate-colored background. The ocular markings are nearly circular, and the inner light colored ring is nearly as wide as the one enclosing it. There are also traces of another light colored zone or ring outside the latter. The inmost dark core is conspicuously smaller than in the specimens described above.

The dimensions are as follows:

	mm.
Total length	340
Length of body (dorsal)	53
Width of body	50
Width of neck	32
Width of head	37
Length of right dorsal arm	230
Length of left dorsal arm	260
Length of right second arm	200
Length of left second arm	265
Length of right third arm	102[3]
Length of left third arm	160[3]
Length of right ventral arm	110[3]
Length of left ventral arm	240
Length of hectocotylus	3[3]
Length of umbrella between dorsal arms	33
Length of umbrella between ventral arms	32
Diameter of oculation, maximum	11½ x 14
Diameter of oculation, excluding outermost light ring	8 x 10

[3] Regenerating.

[Polypus membranaceus (Quoy and Gaimard, 1832).]

Octopus membranaceus Quoy and Gaimard, 1832, p. 89, pl. 6, fig. 5.
Octopus membranaceus d'Orbigny and Férussac, 1838, p. 43, Poulpes, pls. 10, 28 (*fide* d'Orbigny).
Octopus membranaceus d'Orbigny, 1845, p. 181.
Octopus membranaceus Gray, 1849, p. 13.
Octopus membranaceus Tryon, 1879, p. 124, pl. 28, figs. 20, 21.
Amphioctopus membranaceus Fischer, 1882, p. 333.
Octopus membranaceus Brock, 1887, pp. 609, 612.
Octopus membranaceus Ortmann, 1888, p. 662 (mere note).
Octopus areolatus Joubin (pars), 1894, p. 28.

Reported from Japan by Tryon, who included with this species as synonyms the *O. ocellatus* and *O. sinensis* of d'Orbigny. The occurrence of undoubted *membranaceus* in this region needs confirmation.

Family AMPHITRETIDÆ Hoyle, 1886.

Genus AMPHITRETUS Hoyle, 1885.

Amphitretus pelagicus Hoyle, 1885.

Amphitretus pelagicus Hoyle, 1885, p. 271, fig. 106.
Amphitretus pelagicus Hoyle, 1885*a*, p. 235.
Amphitretus pelagicus Hoyle, 1885*c*, p. 113, fig.
Amphitretus pelagicus Hoyle, 1886, pp. 4, 67, etc., pl. 9, figs. 7–9.
Amphitretus pelagicus Ijima and Ikeda, 1902, pp. 85–101, text figs. 1–3, pl. 2.

Distribution.—Okinose Bank, near Misaki, Sagami (Ijima and Ikeda). Off the Kermadec Islands (type locality, Hoyle).

Family ALLOPOSIDÆ Verrill, 1881.

Genus ALLOPOSUS Verrill, 1881.

Alloposus pacificus Ijima, 1902.

Alloposus pacificus Ijima in Ijima and Ikeda, 1902, p. 87, note.

A species not yet sufficiently characterized.

Distribution.—Sagami Sea (type locality, Ijima).

Sub-order DECAPODA Leach, 1818.

Division MYOPSIDA d'Orbigny, 1845.

Family LOLIGINIDÆ Steenstrup, 1861.

Genus LOLIGO Schneider, 1784.

Among cephalopods only *Polypus* and *Sepia* exceed the widespread genus *Loligo*, in the number of species known from Japanese waters. The following species have been described or identified from this region:

L. edulis.
L. chinensis.
L. kobiensis.
L. bleekeri.
L. sumatrensis.
L. japonica.
L. tetradynamia.
L. aspera.

Loligo edulis Hoyle, 1885.

Loligo edulis Hoyle, 1885*b*, p. 186.
Loligo edulis Hoyle, 1885*d*, p. 289.
Loligo edulis Hoyle, 1886, pp. 29, 152, etc., pl. 23.
Loligo edulis Ortmann, 1888, pp. 658, 663.
Loligo edulis Brazier, 1892, p. 16 (locality record).

Three specimens in the collections examined agree very fairly with the description given by Hoyle. Two lots of young individuals are referred provisionally to the same species.

Distribution.—Aomori, Mutsu (!); Same, Mutsu (!); Bay of Tokio (!); Yokohama (type locality, Hoyle); Bay of Waka, Kii (!). Port Jackson, Australia (Brazier).

Material Examined.—

No. Sp.	Locality.	Sex.	Collectors.	Where deposited.	Author's Register.
1	Bay of Tokio	♀	E. S. Morse	Yale Univ. Mus., Cat. 9,641	363
2	Bay of Waka, Kii	♂	Jordan and Snyder	L.S.J.U., Cat. 2,030	372
?36	Aomori, Mutsu	juv.	Jordan and Snyder	L.S.J.U., Cat. 2,028	373
? 4	Same, Mutsu	juv.	Jordan and Snyder	L.S.J.U., Cat. 2,029	374

Loligo chinensis Gray, 1849.

Loligo chinensis Gray, 1849, p. 74.
Loligo chinensis Tryon, 1879, p. 145.
Loligo chinensis Ortmann, 1888, pp. 657, 665, pl. 24; pl. 25, figs. 2*a*–2*d*.

Distribution.—Bay of Tokio (Ortmann); Kadsiyama (Ortmann). China (type locality, Gray).

Loligo kobiensis Hoyle, 1885.

Loligo kobiensis Hoyle, 1885*b*, p. 184.
Loligo kobiensis Hoyle, 1885*d*, p. 287.
Loligo kobiensis Hoyle, 1886, pp. 29, 154, etc., pl. 25, figs. 1–10.
Loligo kobiensis Ortmann, 1888, pp. 659, 665.

A species well characterized among all Japanese forms, except *L. aspera*, by its large tentacular suckers, the horny rings of which are devoid of teeth.

Distribution.—Inland Sea (Hoyle); Bay of Kobe, Settsu (type locality, Hoyle); Onomichi, Bingo (!); Nagasaki, Hizen (!); Maizuru, Tango (Ortmann).

Material Examined.—

No. Sp.	Locality.	Sex.	Collectors.	Where deposited.	Author's Register.
2	Onomichi, Bingo	♂ ♀	Jordan and Snyder	L.S.J.U., Cat. 2,031	365
2	Nagasaki, Hizen	♀	Jordan and Snyder	L.S.J.U., Cat. 2,032	366

Loligo bleekeri Keferstein, 1866.

Loligo Bleekeri Keferstein, 1866, p. 1402, pl. 122, figs. 9, 10; pl. 127, fig. 14.
Loligo Bleekeri Tryon, 1879, p. 149, pl. 57, figs. 185, 186.
Loligo Bleekeri Brock, 1882, p. 604.
Loligo Bleekeri Appellöf, 1886, p. 31, pl. 1, figs. 7–10.
Loligo bleekeri Hoyle, 1886, pp. 30, 158, etc.
Loligo bleekeri Ortmann, 1888, pp. 664, 665 (mere note).
Loligo bleekeri Joubin, 1894, p. 56.
Loligo bleekeri Wülker, 1910, pp. 10, 36, etc., pl. 4, fig. 30 (digestive system).

Distribution.—Aburatsubo, Sagami (Wülker); Nagasaki, Hizen (Appellöf). Amboina (Joubin).

Loligo sumatrensis d'Orbigny, 1839.

Loligo sumatrensis d'Orbigny, in d'Orbigny and Férussac, 1839, p. 317; Calmars, pl. 13, figs. 1–3 (*fide* Hoyle).
Loligo sumatrensis d'Orbigny, 1845, p. 349.
Teuthis sumatrensis Gray, 1849, p. 77.
Loligo Sumatrensis Tryon, 1879, p. 145, pl. 58, figs. 190, 191 (after d'Orb.).
Loligo sumatrensis ? Appellöf, 1886, p. 32, pl. 1, fig. 11; pl. 3, figs. 11–15.
Loligo sumatrensis Ortmann, 1888, p. 664 (merely listed).

Distribution.—Nagasaki, Hizen (Appellöf). Sumatra (type locality, d'Orbigny).

Loligo japonica Steenstrup, 1885.

Loligo japonica Steenstrup, MS., in Hoyle, 1885*b*, p. 187.
Loligo japonica Steenstrup, MS., in Hoyle, 1885*d*, p. 290.
Loligo japonica Hoyle, 1886, pp. 30, 157, etc., pl. 24, figs. 7–15.
Loligo japonica Ortmann, 1888, p. 663.

The nearest ally of this distinct little species is the next following and it now appears quite likely that the two are identical.

Distribution.—Yokohama (Hoyle); Aburatsubo, Sagami (Wülker).

Loligo tetradynamia Ortmann, 1888.

Loligo tetradynamia Ortmann, 1888, p. 659, pl. 23, figs. 4*a*–4*k*; pl. 25, fig. 1.

This small and curious species, although admittedly showing close affinity to *L. japonica*, was differentiated by Ortmann on the following grounds:

1. The suckers of the lateral arms are very much larger than those of the dorsal and ventral pairs, a condition prevailing equally in both sexes.
2. There are no suckers upon the buccal membrane.
3. The arms of the third pair do not possess a membranous keel.
4. The structure of the hectocotylus is different.

Viewed casually, these features appear sufficiently diagnostic. Nevertheless, an examination of the large series of specimens before me causes me to incline very strongly to the opinion that *L. tetradynamia* will eventually prove to be entirely synonymous with *L. japonica,* although the differences apparent in the descriptions of the hectocotylized arms and one or two other less important divergencies deter me at present from uniting them. In this regard a comparison of the respective type specimens with one another would certainly prove of the utmost service.

The present specimens appear to belong beyond dispute to *L. tetradynamia*, and yet in several particulars Ortmann's diagnosis is not quite sufficient to embrace them. The hectocotylus is as described by Ortmann. Likewise the suckers of the lateral arms are invariably of conspicuously greater size than those of the dorsal and ventral pairs. However, this statement is decidedly not true of both sexes in equal degree, since in all the males I have seen the suckers of the lateral arms are at least half again as large as those of a female of the same size. Other differences to be noted are that the horny rings of the larger tentacular suckers are toothed all round, not alone upon the distal border, with some 23–25 blunt teeth, and that the arms of the third pair are possessed of a decided keel.

Indeed, the females accord suspiciously well with the specimen of *japonica* taken by the Challenger Expedition in the Yokohama Market. The chief points of difference are that here the dorsal arms are distinctly keeled instead of rounded, as stated by Hoyle, and he makes no mention of the great disparity in the size of the suckers, although his phrase "and vary in size in accordance with the arms on which they are situated" may amount to the same thing. Comparison with his excellent figure distinctly fortifies the latter interpretation. Likewise the tentacles are compressed and angular rather than cylindrical, and I have discovered no suckers on the buccal membrane, though I do not regard this observation as proving their absence there. These items of difference, however, seem to be very minor, and were it not for Hoyle's careful description of the curious hectocotylized arm of a male in the Copenhagen Museum which he held to be conspecific with his type, there could be little hesitation in relegating *L. tetradynamia* to the synonymy.

Distribution.—Same, Mutsu (!); Bay of Tokio (type locality, Ortmann, etc. !); Okayama, Bizen (!); Kochi, Toza (Ortmann); Kawatana, Hizen (!).

Material Examined.—

No. Sp.	Locality.	Sex.	Collectors.	Where deposited.	Author's Register.
2	Same, Mutsu	♂	Jordan and Snyder	L.S.J.U., Cat. 2,033	369
5	Bay of Tokio	♂ ♀	E. S. Morse	Yale Univ. Mus., Cat. 9,010	367
1	Bay of Tokio	♀	E. S. Morse	S.S.B., coll., 2,404	368
14	Tokio	♂ ♀	Jordan and Snyder	L.S.J.U., Cat. 2,034	370
1	Okayama, Bizen	♂	Alan Owston	L.S.J.U., Cat. 2,086	393
7	Kawatana, Hizen	♂ ♀	Jordan and Snyder	L.S.J.U., Cat. 2,035	371

Loligo aspera Ortmann, 1888.

Loligo aspera Ortmann, 1888, p. 661, pl. 25, figs. 3*a*–3*d*.

This species is so far known only from Kochi, Toza, the type locality, and I am not aware that it has been observed since its original description by Ortmann.

Genus **SEPIOTEUTHIS** Blainville, 1825.

[**Sepioteuthis sinensis** d'Orbigny, 1839.]

Sepioteuthis sinensis d'Orbigny, in d'Orbigny and Férussac, 1839, p. 304.
Sepioteuthis sinensis d'Orbigny, 1845, p. 329.
Sepioteuthis sinensis Tryon, 1879, p. 154.

D'Orbigny applied this name to a squid said to be eaten by the Japanese. No specific characters have been given.

Sepioteuthis lessoniana Férussac, 1826. Pl. VI, figs. 3, 5.

Sepioteuthis Lessoniana Férussac in d'Orbigny, 1826, p. 155.
Sepioteuthis Lessoniana Lesson, 1830, p. 241, pl. 11.
Sepioteuthis Lessoniana d'Orbigny and Férussac, 1839, p. 302; Sepiot., pl. 1; pl. 6, figs. 9–14 (*fide* Hoyle).
Sepioteuthis Lessoniana d'Orbigny, 1845, p. 326.
Sepioteuthis Lessoniana Gray, 1849, p. 80.
Sepioteuthis Lessoniana Keferstein, 1866, p. 1402, pl. 122, fig. 7.
Sepioteuthis Lessoniana Tryon, 1879, p. 152, pl. 62, fig. 212; pl. 64, fig. 213.
Sepioteuthis lessoniana Appellöf, 1886, p. 31.
Sepioteuthis lessoniana Hoyle, 1886, pp. 27, 151, etc.
Sepioteuthis lessoniana Ortmann, 1888, pp. 657, 665.
Sepioteuthis lessoniana Ortmann, 1891, p. 676.
Sepioteuthis Lessoniana Joubin, 1894, p. 39.
Sepioteuthis Lessoniana Joubin, 1898, p. 26.
Sepioteuthis lessoniana Hoyle, 1909, p. 265.
Sepioteuthis lessoniana Wülker, 1910, pp. 11, 28, 36, etc., pl. 3, fig. 28; pl. 4, figs. 29, 31.

Body elongate, massive, dorso-ventrally compressed; contour elongate ovoid, tapering rapidly to a blunt point behind. Mantle very

thick and heavy; its anterior margin free, produced forward to a rounded point in the nuchal region, and similarly, but to a much less degree, ventrally; broadly emarginate below the funnel. Fins large; attached along the entire length of the mantle, which they slightly exceed both in front and behind in the specimen furnishing the description (a ♂ from Wakanoura), though not in the others. Cartilaginous articulations as usual in the genus, large and very prominent.

Head of moderate size, squarish. Eyes large and prominent. In front of the orbit is a large pore; behind it the integument is raised into a very prominent crest, bilobate, curved, and somewhat excavated in front, with the "olfactory" pore sheltered just below its dorsal margin. Funnel very large, very wide at the base and tapering bluntly to a rounded extremity; aperture large and directed downward, with well-developed lips and valve; supported above by a fleshy bridle at the base of the funnel groove.

Arms of moderate length, stout, squarish, unequal; the order of length not constant, but in my best specimens 3, 4, 2, 1. All the arms are outwardly keeled and provided with a broad marginal membrane supported by numerous transverse fleshy processes having their origin between the bases of the sucker pedicels. The latter is best developed on the third pair and least on the ventral arms. The keel, however, attains its maximum on the ventral arms, where it is developed as a broad, thickened web ensheathing the base of the tentacles. These arms are also furnished with a second less prominent keel running down their inner margins. Suckers large, regularly alternating in two rows on all the arms; horny rings prominent, armed with about 18 to 22 stout acute, curved teeth.

The hectocotylization affects the left ventral arm of the male after the fashion usual in this genus and in *Loligo*. The first 19 pairs of suckers are normal; they then become much reduced, and after the 24th pair are supplanted by stout conical papillæ. On the first four or five papillæ the suckers persist, though in a very rudimentary way, but soon become entirely obsolete. The integument on and between the papillæ of the Wakanoura specimen is much folded and lobed, a condition perhaps due to the action of the preservative.

Tentacles rather short, laterally much compressed and keeled on both outer and inner margins. The outer keel becomes expanded to form a broad fleshy web along the distal portion of the club. The inner carina soon becomes obsolete and is succeeded by an abruptly

differentiated flattened area, where the integument is finely and irregularly plicate. Club large, comprising nearly half the length of the tentacle, and provided with a broad trabeculate marginal membrane similar to that of the sessile arms. Suckers in four rows, large near the middle, diminishing in size toward either end, distally becoming very minute, and showing the spoon-shaped arrangement at the tip described by Goodrich (1896, p. 6) and Hoyle (1904, p. 31) for related species; horny rings with 18-20 stout, acute, incurved teeth.

Buccal membrane seven-pointed, bearing from three to five minute suckers on each lappet. The suckers are pedunculate and have horny rings.

Gladius lanceolate; the lateral thickenings diverging from the thick midrib extend along the middle of the wings for the posterior two-thirds of their length (Pl. VI, fig. 5).

Color of preserved specimens brownish-buff, heavily reticulated above with purplish-black, lighter below, and with the ventral surfaces of the fins unmarked.

Measurements.

The more important measurements of two male specimens are given below:

	No. 36. mm.	No. 341. mm.
Length, total	360	400+
Length of mantle, dorsal	207	235
Width of mantle	70	75
Width across fins at widest point	165	156
Width of fin at widest point, ventral	50	48
Width of head	53	61
Length of dorsal arm	61	68
Length of second arm	76	84
Length of third arm	95	102
Length of ventral arm	90	95
Length of hectocotylized portion	26	24
Length of tentacle	127	158
Length of tentacle club	63	79
Diameter of largest sucker on third arm	4	4
Diameter of largest sucker on tentacle	5	6

Distribution.—Tsuruga, Echizen (!); Tokio (Ortmann); Misaki, Sagami (!); Aburatsubo, Sagami (Wülker); Wakanoura, Kii (!); Bay of Waka, Kii (!); Kagoshima, Satsuma (Ortmann); Nagasaki, Hizen (Appellöf, !); Fusan, Korea (!). Trincomalee (d'Orbigny);

Ceylon (Ortmann); Cape Fabre (d'Orbigny); Java (d'Orbigny, Keferstein); Ternate (Hoyle); Amboina (Joubin); New Guinea (d'Orbigny); Apia, Samoa (!); Kandava, Fiji (Hoyle); New Zealand (Gray).

As the original figures of d'Orbigny and Férussac have not been accessible to me, I have not referred the specimens in hand to this species without a certain amount of hesitation, and hence have thought it well to enter somewhat fully into the details of their description. Few of the species of *Sepioteuthis* have been as well characterized in the literature as they should be, but I have little doubt that the present material is at least identical with that from the same region which authors before me have identified as *S. lessoniana*. The species is said to attain a length of three feet, but the maximum dimension given by Hoyle in respect to the specimens taken by the "Challenger" is only 570 mm.

If correctly understood, this form would seem to have a surprising range in the tropical and subtropical waters of the Pacific, and possibly several other nominal species should be relegated to the synonymy.

Material Examined.—

No. Sp.	Locality.	Sex.	Collectors.	Where deposited.	Author's Register.
1	Tsuruga, Echizen	♀	Jordan and Snyder	L.S.J.U., Cat. 2,041	35
3	Misaki, Sagami	juv.	Jordan and Snyder	L.S.J.U., Cat. 2,036	37
9	Misaki, Sagami	juv.	Jordan and Snyder	L.S.J.U., Cat. 2,037	40
4	Bay of Waka, Kii	juv.	Jordan and Snyder	L.S.J.U., Cat. 2,039	41
1	Wakanoura, Kii	♂	Jordan and Snyder	L.S.J.U., Cat. 2,038	36
4	Nagasaki, Hizen	juv.	Jordan and Snyder	L.S.J.U., Cat. 2,040	38
1	Fusan, Korea	♂	D. S. Jordan	L.S.J.U., Cat. 2,042	341
6	Fusan, Korea	♂ ♀	D. S. Jordan	L.S.J.U., Cat. 2,043	342
3	Apia, Samoa	♂ ♀	D. S. Jordan	L.S.J.U., Cat. 2,044	39

Sepioteuthis sieboldi Joubin, 1898.

Sepioteuthis Sieboldi Joubin, 1898, p. 27 (*fide* Hoyle).

I have not seen the description of this species.

Distribution.—Japan (Joubin). Waigeou (Joubin).

Sepioteuthis brevis Owen, 1881.

Sepioteuthis brevis Owen, 1881, p. 137, pl. 26, fig. 1.
Sepioteuthis brevis (= *lessoniana* ?) Wülker, 1910, pp. 11, 22.

At best a doubtful species.

Distribution.—Japan (Owen).

Family **IDIOSEPIIDÆ** Appellöf, 1898.

Genus **IDIOSEPIUS** Steenstrup, 1881.

Idiosepius paradoxa (Ortmann, 1888).

? *Idiosepius pygmæus* Steenstrup, 1881, p. 219, pl. 1, figs. 11–22.
Microteuthis paradoxa Ortmann, 1888, pp. 649, 665, pl. 22, fig. 4.
Microteuthis paradoxa Joubin, 1902, p. 105, fig. 15.
Idiosepius pygmæus Wülker, 1910, p. 22 (merely listed).

By Wülker this species is considered to be identical with *I. pygmæus* Steenstrup, and such may well prove to be the case.

Distribution.—Kadsiyama (type locality, Ortmann).

Family **SEPIOLIDÆ** Steenstrup, 1861.

Sub-family SEPIOLINÆ s. s.

Genus **INIOTEUTHIS** Verrill, 1881.

Inioteuthis japonica (Tilesius MS.?) Verrill, 1881. Pl. V, fig. 5.

? *Sepiola Japonica* d'Orbigny (from Tilesius MS.) in d'Orbigny and Férussac, 1839, p. 234, No. 3 (*fide* d'Orbigny).
? *Sepiola Japonica* d'Orbigny, 1845, p. 251.
? *Sepiola* ? *Japonica* Gray, 1849, p. 93.
? *Sepiola japonica* Steenstrup, 1857, pp. 93, 94.
? *Sepiola Japonica* Tryon, 1879, p. 157.
Inioteuthis Japonica Verrill, 1881, p. 417, footnote.
Inioteuthis japonica Appellöf, 1886, p. 16.
Inioteuthis japonica Hoyle, 1886, pp. 17, 113, etc.
Inioteuthis japonica Ortmann, 1888, p. 647, pl. 21, fig. 6; pl. 22, fig. 2.
Inioteuthis japonica Joubin, 1897*a*, p. 101.
Sepiola japonica Joubin, 1902, p. 95, fig. 10.
Inioteuthis japonica Hoyle, 1904, p. 27.
Inioteuthis japonica Wülker, 1910, p. 10.
Sepiola inioteuthis Naef, 1912*a*, pp. 265, 266, 268.

The species *Sepiola japonica* was published by d'Orbigny from a manuscript letter of Tilesius and I cannot find that any specimens were seen by d'Orbigny himself. Gray (1849) copied his diagnosis from d'Orbigny, but expressed some doubt as to its proper reference to *Sepiola*. Then except for a brief mention in Tryon's "Manual" (1879) we find it otherwise unnoticed for over thirty years. Finally a small collection of squids obtained by Prof. E. S. Morse in the Bay of Tokio was sent by him to Prof. A. E. Verrill, then engaged with his report on "The Cephalopods of the Northeastern Coast." These specimens furnished the descriptions of two species which were accordingly published in the appendix of this report as a footnote (1881, p. 417), and the genus *Inioteuthis* was erected to receive them. The form now under consideration was expressly made the

type[4] and identified with the *Sepiola Japonica* of d'Orbigny, although upon exactly what grounds other than general probability does not seem to be entirely clear. A great many points yet remain to be cleared up, and, as I have been able through the kindness of Prof. Verrill himself to secure the use of the majority of his specimens, they have been made the basis of the more extended description of the species given herewith:

Body short and saccular; mantle in the male somewhat bell-shaped, widest in front, tapering rapidly to a rounded posterior extremity; in the adult female more rounded and cylindrical, less tapering, and relatively much more plump. Nuchal commissure rather wide, but considerably narrower than in *Euprymna morsei*. Mantle margin usually, but not always, more or less emarginate beneath, permitting the siphon a greater freedom of movement.

Fins thin, small, subcircular, forming a lobe in front; attachment narrow, considerably above the median horizontal plane of the body; position with regard to the mantle almost median in the adult, but in the young placed much further back.

Head oblong, flattened above; width inclusive of the eyes about twice the length. Funnel long, tapering, rather slender. Locking apparatus comprising an oblong groove on either side of the base of the funnel and folds to correspond on the inner surface of the mantle. The grooves are provided with a thickened reflexed margin. The folds are simple narrow ridges, much longer than the grooves.

Eyes of moderate size; openings small. "Olfactory organ" situated considerably below and behind the lid opening.

Arms short, fleshy, but fairly slender; the first pair the shortest and smallest, the rest subequal; third pair obscurely carinate, stouter and somewhat longer than the others. A poorly developed web connects the arms at the base, but is obsolete or wanting between the ventral pair. Suckers in two alternating rows; in the female very minute and alike on all the arms; somewhat modified in the male. Left dorsal arm of the male very conspicuously hectocotylized; at its extreme base appear one or two very minute and rudimentary suckers, these immediately succeeded by a huge ridge-like swelling, irregularly oval in shape and somewhat suggestive of the concha of the human ear; this curious organ extends about half way up the arm and is apparently formed by the fusion of exceedingly modified and obscured sucker pedicels, though it bears no suckers. The figure of the structure given by Ortmann is recognizable, but scarcely

[4] The second species, *I. morsei*, has since become the type of Steenstrup's genus *Euprymna*.

more. The distal half of the arm is sucker bearing, but on the specimen in hand only the pedicels remain. The right dorsal arm is essentially like that of the ♀ except that the suckers along its central portion are very much larger than the rest and hence fewer in number. The same peculiarity is true of the outer row of suckers on the second pair of arms of the ♂ and to a much less degree of the ventral arms. The suckers of the third-arm pair are very minute and relatively very widely spaced.

Individual suckers of the sessile arms nearly spherical, with very small apertures and smooth horny rings. They break off with such ease that few of my specimens retain an average of more than two or three on each arm.

Tentacles slender, as long as the body, but when bent back not extending beyond the fins; tentacular club but little thickened, with a thin membrane along its inner margin, its inner surface villous; a microscopic examination shows the velvety appearance to be due to the exceeding minuteness of the suckers which clothe it; the latter long pediceled and closely placed in about eight rows. Individual suckers bell-shaped, the wide openings surrounded by a papillary area, outside of which is a thin, broad, outwardly flaring, striate membrane; horny rings well developed, seemingly armed with twenty or more distinct acute teeth, but it is not outside the range of possibility that the apparent teeth may be merely very large papillæ or chitinous projections from the papillary border.

Beak and radula not examined. Gladius none.

Color when living not observed; in alcohol a pale yellowish-brown, the chromatophores appearing as bluish-black spots, quite small and distinct on the mantle, larger and more run together on the head.

Measurements.

	Cotypes.			
Sex	♂	♂	♀	♀
Number in author's register	[112]	[111]	[391]	[392]
Length total (excluding tentacles)	40	32	35	31
Length of mantle, dorsal	19	16	17.5	15
Width of body	12	12	13	10.5
Width of nuchal commissure	5.5	5	6	5
Width across fins	23	....	25	24
Length of fin, extreme	10	...	9.5	9
Length of fin at point of attachment.	6.5	5.5	6	5.5
Length of dorsal arm (left side)	16	9	10.5	10
Length of second arm	18	14	12	12
Length of third arm	18	14	13	12
Length of ventral arm	13	13.5	12	10
Length of tentacle	27	23	26	20

Type.—Cat. No. 9,639 (part), Yale University Museum; a male. Cotypes of same sex in Yale University Museum and the author's collection.

Type Locality.—Bay of Yeddo (Tokio), Japan; Edward S. Morse.

Distribution.—Matsushima, Rikuzen (!); Bay of Tokio (!); Enoshima, Sagami (!); Aburatsubo, Sagami (Wülker); Nagasaki, Hizen (Joubin).

Specimens Examined:—

No. Sp.	Locality.	Sex.	Collectors.	Where deposited.	Author's Register.
2	Bay of Tokio	♂	E. S. Morse	Yale Univ. Mus., Cat. 9,639 (cotypes)	111
1	Bay of Tokio	♂	E. S. Morse	S.S.B., (cotype)	112
5	Bay of Tokio	♀	E. S. Morse	Yale Univ. Mus., Cat. 9,639*a*	390
1	Bay of Tokio	♀	E. S. Morse	S.S.B.,	391
1	Matsushima, Rikuzen	♀		L.S.J.U., Cat. 2,019	392
1	Enoshima, Sagami	♀	A. Owston	L.S.J.U., Cat. 2,020	389

Since the establishment of the genus and the elimination of *Euprymna morsei*, *Inioteuthis* has been enriched by the addition of but one other species, the *I. maculosa* Goodrich 1896. In the meanwhile the actual status of the group has been the occasion of considerable discussion. Unquestionably, the most important known difference separating *Inioteuthis* from *Sepiola* is the absence of a gladius in the former, the generic significance of which feature in a case such as the present is certainly not yet fully established.

I. maculosa does not seem to differ very strikingly from the Japanese species and further information regarding it would be very useful. It has been reported from the Andaman Islands, Ceylon, and the Persian Gulf.

Genus **EUPRYMNA** Steenstrup, 1887.

Euprymna morsei (Verrill, 1881) Steenstrup, 1887. Pl. VI, figs. 1, 2.

Inioteuthis Morsei Verrill, 1881, p. 417, footnote.
? *Sepiola bursa* Pfeffer, 1884, p. 6, fig. 6.
Inioteuthis Morsei Appellöf, 1886, p. 15, pl. 2, figs. 15, 16; pl. 3, figs. 16, 19, 20, 23.
Inioteuthis morsei Hoyle, 1886, pp. 17, 112, etc., pl. 14, figs. 1–9.
Euprymna Morsei Steenstrup, 1887, p. 66 [20].

Euprymna Morsei Steenstrup, 1887*a*, p. 89 [43].
Inioteuthis morsei Ortmann, 1888, pp. 647, 665, pl. 21, fig. 7; pl. 22, fig. 3.
Inioteuthis Morsei Joubin, 1897*a*, p. 101 (dimensions, *fide* Hoyle).
Inioteuthis Morsei Joubin, 1902, p. 97, figs. 11, 12.
Euprymna morsei Hoyle, 1904, p. 26.
Euprymna morsei Hoyle, 1904*a*, p. 198.
Euprymna morsei Hoyle, 1905, p. 981.
not *Euprymna morsei* Berry, 1909, p. 418 (locality record).
Euprymna morsei Wülker, 1910, pp. 9, etc., pl. 1, fig. 9; pl. 3, figs. 23, 24; pl. 4, fig. 40 (anatomy).
Euprymna morsei Naef, 1912, p. 247.

[5] Animal small, sepioliform; body short, thick, rounded, the lateral diameter on the average equal to about three-fourths of the length. Fins large, semicircular, attached very obliquely in advance of the middle of the body; broadest posteriorly; anterior lobe conspicuous and abruptly notched at its inner margin so that the attached portion of the fin comprises but about the posterior two-thirds of the total length. Mantle margin projecting well forward ventrally, but with a deep, notch-like emargination just below and encompassing the funnel; united dorsally with the head by means of a very wide commissure, so that the opening of the mantle cavity attains only to a point just back of, and superior to, the eye opening on either side.

Head almost as broad as the body, the length somewhat exceeded by the width; flattened above; beneath slightly excavated for the reception of the funnel. Eyes very large and prominent, somewhat swollen. Funnel large, very elongate, but in the best preserved specimens not nearly reaching to the margin of the web between the ventral arms; tip with three heavy longitudinal ridges[6] on its interior surface, just back of which on the dorsal wall is a minute triangular valve; general surface of interior transversely ridged. Funnel organ posterior in position, large, tripartite, comprising a broad triangular-hepatiform median pad on the dorsal wall and a pair

[5] Verrill's original diagnosis (1881, p. 417, footnote) is as follows:

"*Inioteuthis Morsei* V., sp. nov. This is easily distinguished from the preceding [*I. japonica*] by the presence of four crowded rows of suckers on all the arms; the suckers are attached by slender pedicles, which arise from the top of prominent, thickened, basal stems. The tentacular clubs are well developed, with exceedingly numerous, very minute suckers, in more than sixteen rows. Fins large, situated in advance of the middle of the body. Dorsal and ventral arms about equal; two lateral pairs longer, the third pair slightly longer than the second. Mantle edge, beneath, with a large emargination; dorsal commissure broad.

"No males of this species are in the collection; therefore I refer it to this genus only provisionally. It has no pen."

[6] I am inclined to consider these ridges a physiological modification attendant upon the conditions of preservation of the specimen furnishing the description.

of large elongate-pyriform cushions on the ventral wall; a narrow membranous ridge running down the centre of the median pad terminates anteriorly in a minute slender papilla.

Arms rather short, but the shortest ones usually at least as long as the mantle, the others somewhat longer; unequal, the order of relative length usually about 2, 3, 4 = 1[7]; dorsal (outer) margin of ventral arms carinate, the others rounded; outer surfaces smooth. Umbrella lacking or at best rudimentary between the dorsal arms, better developed between the dorsal and second arms and between these and the third pair; between the third and fourth pairs it extends for over one-quarter of their length as a broad web ensheathing the base of the tentacles, becoming again much reduced or even obsolete between the ventral arms. Suckers on all the arms closely crowded in four rows, except at the extreme base where they appear in two to three rows; obliquely poised on stout conical pedicels so that they are easily rubbed off, leaving the stumpy pedicels intact; nearly spherical; apertures small, with smooth horny rings.

The above remarks I believe to be equally applicable to either sex, but in the detailed arrangement and appearance of the suckers a number of fairly conspicuous differences become evident. In the ♀ the suckers at corresponding parts of all the arms are subequal and exceedingly minute, their diameter little greater than that of the thickened bases of the pedicels. In the ♂, left ventral arm conspicuously hectocotylized; distinctly thicker and perhaps a little shorter than its mate; all the suckers nearly as small as in the ♀, the first two or three pairs in two to three rows, the remainder in four; about where the four-rowed condition commences, two components of the outermost (ventral) row become modified as a pair of elongate suckerless papillæ; subsequent to this point ensue about six quartets of normal suckers reaching somewhat less than half way up the arm. Here the suckers of the two ventral rows are succeeded by a single series of much enlarged, compressed, transversely elongate, tightly palisaded papillæ of a very characteristic appearance, bearing the merest rudiments of suckers at their tips; these rudiments have mouth-like apertures, but do not have the appearance of mere lips as figured by Hoyle for *E. stenodactyla*, since close examination reveals the presence of well-developed though minute horny rings, their margins minutely but distinctly dentate with a number of acutely

[7] Variations from this formula occur frequently in my material, but in this instance the majority of them seem due merely to poor preservation.

pointed triangular teeth. The number of these papillæ is about thirty, the largest occurring in the neighborhood of the tenth, thence gradually diminishing in size toward the tip. The suckers of the dorsal rows maintain their arrangement in two series and there are about three more pairs of unmodified suckers than in the ventral row, but at this point they, too, become affected, their pedicels much swollen and puffed out, and the suckers themselves relatively much reduced, though not to quite so great a degree as in the ventral row. The horny ring from one of these also shows minute teeth. The right dorsal arm is longer, more slender, and more closely approximates the condition found in the ♀, but most of the suckers from the present specimens have been lost through abrasion, so there may have been minute differences now impossible to observe. On the second arms most, if not all, of the suckers of both the two outermost rows are two to three times as large as those of the two median rows, except near the tip, where all are again subequal. My specimens do not warrant the assertion that a similar condition prevails on the third pair, but it certainly reappears on the ventral arms and is here again nearly as conspicuous as on those of the second pair. A large sucker taken from the latter is rotund, its base somewhat heart-shaped; horny rings deep, smooth, but with a lateral indentation on each margin, above which a large, thin, hood-shaped expansion obstructs part of the aperture and destroys its otherwise nearly circular outline.

Tentacles stout, elastic, cylindrical; inner surface slightly flattened; half as long again as the body and more. Clubs little expanded, keeled, tips recurved; inner face rounded, everywhere armed with exceedingly numerous and minute, long-stalked suckers, giving it a finely villous appearance.

Buccal membrane fleshy, pointed, rugose within.

Radula not examined.

Gladius wanting.

Color in alcohol a light brownish-buff; heavily maculated both above and below with numerous large dark slate-colored chromatophores, which are least numerous on the inner surfaces of the arms and the lower aspect of the fins. On the under side of the latter over the area adjacent to the base of attachment they are absent.

Measurements.

Number in author's register	[291]	[105] Cotype.	[288] Cotype.	[285]
Sex	♀	♀	♀	♀
Length, total	140	64	38	......
Tip of body to base of dorsal arms	58	28	21	......
Tip of body to tip of dorsal arms	101	43	34	......
Length of mantle, dorsal	40	20	15	30
Width of mantle	26	14	13	......
Width of dorsal commissure	14	8	8	......
Width across fins	58	29	23	43
Length of fins, total	22	10	9	......
Length of fins along plane of attachment	14	7	7	......
Length of head	19	7	5	......
Width of head	23	13	11	......
Length of right dorsal arm[8]	36	12	12	......
Length of left dorsal arm[8]	35	12	12	......
Length of second arm[8]	46	14+	14	40
Length of third arm[8]	39	15	13	......
Length of ventral arm[8]	36	12	12	......
Length of tentacle	80	36	19	101
Length of tentacle club	16	5	3.5	......
Length of funnel	24	......	......	......

Number in author's register	[290]	[292]	[294]	[285]
Sex	♂	♂	♂	♂
Length, total	119	95	113	......
Tip of body to base of dorsal arms	43	31	48	......
Tip of body to tip of dorsal arms	84	63	85	......
Length of mantle, dorsal	32	21	32	16
Width of mantle	20	15	24	......
Width of dorsal commissure	12	11	16	......
Width across fins	40	28	43+	28
Length of fins, total	16	11	......	......
Length of fins along plane of attachment	10	8	12	......
Length of head	12	10	16	......
Width of head	17	14	19	......
Length of right dorsal arm[8]	37	26	25+	......
Length of left dorsal arm[8]	25	24	29+	......
Length of second arm[8]	40	34	42	15.5
Length of third arm[8]	33+	32	......	......
Length of ventral arm[8]	36	27	35	......
Length of tentacle	74	65	75	19
Length of tentacle club	11	10	10	......
Length of funnel	19	19	22	......

[8] Measured along inner face from outer base of buccal membrane.

Type.—Cat. 9,638, Yale University Museum, a female [S. S. B. No. 105]. Cotypes in Yale University Museum and in Cat. No. 2,402 of the author's collection, also a female.

Type Locality.—Bay of Yeddo (Tokio), Japan; Edward S. Morse; 3 ♀.

Distribution.—Bay of Tokio (Verrill,!); off Misaki, Sagami (Wülker); off Dzushi, Sagami (Wülker); Wakanoura, Kii (!); Bay of Waka, Kii (!); off Kobe, Settsu (Hoyle); Onomichi, Bingo (!); Kagoshima, Satsuma (Ortmann); Kadsiyama (Ortmann); Nagasaki, Hizen (Appellöf, Joubin,!); Takao, Formosa (!). Hong Kong, China (!); Gulf of Manaar (Hoyle); Andaman Islands (Goodrich); Maldive Archipelago (Hoyle).

Specimens Examined.—

No. Sp.	Locality.	Sex.	Collector.	Where deposited.	Author's Register.
1	Bay of Tokio	♀	E. S. Morse	Yale Univ. Mus., Cat. 9,638 (cotype)	105
1	Bay of Tokio	♀	E. S. Morse	S.S.B., Cat. 2,402 (cotype)	288
1	Wakanoura, Kii	♀	Jordan and Snyder	L.S.J.U., Cat. 2,022	293
3	Bay of Waka, Kii	♀ ♂	Jordan and Snyder	L.S.J.U., Cat. 2,023	294
3	Onomichi, Bingo	♀ ♂	Jordan and Snyder	L.S.J.U., Cat. 2,021	292
4	Nagasaki, Hizen	♀ ♂	Jordan and Snyder	L.S.J.U., Cat. 2,024	289
1	Japan	♀	?	L.S.J.U., Cat. 2,025	291
3	Takao, Formosa	♀ ♂	Hans Sauter	L.S.J.U., Cat. 2,026	290
5	Hong Kong, China	♀ ♂	W.H.A.Putnam, 1861	Mus.Comp. Zool., Cat. 1,571	283
1	Hong Kong, China	♀	W.H.A.Putnam	Mus.Comp. Zool., Cat. 3,446	284
2	Hong Kong, China	♀ ♂	W.H.A.Putnam	Mus.Comp. Zool., Cat. 1,537	285

The material at my disposal referable to this species has been so unusual both in quantity and character, including even the

original type specimens of Verrill, that despite the juvenility of the latter and the admittedly unfavorable preservation of the remainder I have thought it well to redescribe the species throughout as carefully and completely as the material would allow. One of the types is likewise figured on Plate VI. Some of the nearly allied species are most puzzlingly close, but it is hoped that the data here given will prove sufficient to prevent its confusion with any of them. It must be confessed, however, that I have been unable to select any characters or combinations of characters which I am certain will suffice to distinguish a series consisting of females alone from any other species of the genus. The males appear to be constantly characterized by the large number of modified suckers on the hectocotylized arm, coupled with the fact that the suckers of *both* the outer rows of the second, third, and fourth arms undergo enlargement, a character exceedingly conspicuous on the second arms at least and in well-preserved material probably on all.

Good descriptions have already been given by Appellöf (1886), Hoyle (1886), Ortmann (1888), and of the anatomy by Wülker (1910). Verrill's types are therefore made the basis of the above notes, with the exception of those portions relating to the ♂, of which he had no specimens. However, his specimens do not differ from the various larger females seen by me in any essential particulars except their dimensions.

This is the commonest Japanese Sepiolid and has been obtained by so many collectors that it must be a species of considerable abundance. Specimens from Formosa do not seem different in any way, nor have I been able to separately identify the large series of individuals from Hong Kong in the Museum of Comparative Zoology. The latter is also the type locality for Pfeffer's *Sepiola bursa*, and should not specimens in better preservation prove otherwise, there can be little doubt that this name is a complete synonym of *E. morsei*.

Genus STOLOTEUTHIS Verrill, 1881.

Stoloteuthis nipponensis Berry, 1911. Pl. V, figs. 1–4.

Stoloteuthis nipponensis Berry, 1911, p. 39, fig.
Sepiolina nipponensis Naef, 1912, p. 248.

Body small, compact, short, plump, sepioliform, rounded behind. Mantle attached to the head dorsally by a rather narrow commissure (4.5 mm.); free below and produced forward beneath the head, its edge sinuous and slightly emarginate in front, so as to expose the extreme tip of the funnel, otherwise entirely hidden. Fins large, semicordate, the forward lobe extending from the anterior base of

attachment as far as the mantle margin; posterior lobe scarcely developed; nearly median in position, the plane of attachment nearly level with the dorsal surface of the mantle.

Head very large, as broad as the body, flattened above, excavated beneath. Eyes large with rather large openings; the right eyelid appears to be free all round, the left eye has only the lower lid free. Funnel rather small, flexed upward so as to lie closely in the excavation formed by the hollowed under surface of the head. A slight curved longitudinal groove with a raised and reflexed edge, situated on either side of the funnel quite far back, articulates with a corresponding ridge on the inner surface of the mantle; the ridge similarly curved, rather heavy, and notably longer than the groove. "Olfactory organ" situated on the same level with the lower eyelid and just behind it.

Arms stout, thick, fleshy, and rather short, the order of length 2, 1, 3, 4, only the ventral arms noticeably shorter than the others; each with two rows of spherical short-pediceled suckers extending for their entire length. Both dorsal arms hectocotylized; squarish, prominently keeled above, unequal, the right slightly the larger; much swollen; suckers very small, even at the base of the arms, whence they gradually diminish in size toward the tip, the two rows very regularly alternating; inner surface of each arm curiously striate with numerous fine transverse corrugations arranged more or less in bands to correspond with the bases of the sucker pedicels. Suckers of the second pair of arms slightly larger, but still quite small, excepting some five pairs along the middle of the arm which are conspicuously larger than the rest; third pair similar in structure to the second pair; ventral arms shorter and more slender than the others, their suckers mainly lost in the specimen examined. The pedicels of all the suckers, especially the enlarged ones, are very brittle and delicate. Openings of suckers very small; horny rings smooth. Arms connected at the extreme base by a poorly developed web or umbrella which is totally lacking between the ventral pair; dorsal arms laterally angled and with a dorsal keel; in the second pair angles and keel become obsolete, but reappear again in the third pair; ventral arms keeled along the outer side.

Tentacles stout and fleshy; about as long as the mantle; the club furnished with a membranous keel, but otherwise not exceeding the stalk in diameter; suckers extremely minute, subequal, irregularly arranged in at least 12 (perhaps as many as 16) rows, giving the club a velvety appearance; peduncles slender; the horny rings

under the high power *seem* to be smooth, but the material examined is imperfectly stained.

Color in life unknown; in alcohol a pale brown, suffused here and there with blackish-purple. Chromatophores numerous, appearing as dark dots. As in the other species of the genus, the ventral surface of the mantle is marked by a large shield-shaped patch, over which the chromatophores are exceedingly fine, numerous, and evenly distributed; the patch is bordered by a rather indistinct slaty-blue margin.

Beak and radula not examined. Gladius absent.

Type.—Cat. No. 2,027 (Invertebrate Series) of the Stanford University collections; a male. The type is unique. [S. S. B. No. 32.]

Type Locality.—Suruga Bay, Japan.

Measurements.—The chief measurements of the type are as follows:

	mm.
Total length exclusive of tentacles	38.5
Medio-dorsal length of mantle	17
Medio-ventral length of mantle	20
Width of body	13
Width across fins	24
Length of fin, total	13
Length of fin at plane of attachment	9
Width of nuchal commissure	4.5
Width of head	14
Length of head	9
Length of dorsal arm	11
Length of second arm	12
Length of third arm	10.5
Length of ventral arm (measured from inner base)	10
Length of tentacle	20

S. nipponensis appears to be very different from either of the only two species of the genus heretofore described, although sharing with them the curious combination of characters upon which the group was founded. The generic type—*S. leucoptera* Verrill, from the North Atlantic—differs in the more complete webbing of the arms, their relative shortness, the more anterior position of the fins, hectocotylization (though affecting the same arms), and other details. It is also stated to have the eyelids free all round, but from the appearance of the present specimen this should possibly be regarded as a physiological condition, rather than a permanent feature as in the œgopsid decapods.

The other Pacific form—*S. iris* Berry, from the Hawaiian Islands—has a totally different aspect and stands quite alone in the relative

magnitude of its head and fins and the great width of the nuchal commissure. If the type is adult, it is also a much smaller species than *S. nipponensis*.

Naef (1912) has recently made *S. nipponensis* the type of a new genus *Sepiolina*.

Sub-family ROSSIINÆ.

Genus **ROSSIA** Owen, 1834.

Rossia sp.

Dr. Heath has shown me egg capsules containing late embryonic stages of some species of *Rossia*. The animals were far enough advanced to exhibit clearly the distinctive characters of the genus. They were taken off the northwestern coast of Honshu.

Genus **PROMACHOTEUTHIS** Hoyle, 1885.

Promachoteuthis megaptera Hoyle, 1885.

Promachoteuthis megaptera Hoyle, 1885, p. 273, fig. 109.
Promachoteuthis megaptera Hoyle, 1885*b*, p. 182.
Promachoteuthis megaptera Hoyle, 1885*d*, p. 284.
Promachoteuthis megaptera Hoyle, 1886, pp. 19, 120, etc., text fig. 3, pl. 14, figs. 10–14.
Promachoteuthis megaptera Joubin, 1902, p. 109, fig. 17.

Distribution.—1,875 fathoms, southeast of Nosima (type locality —Hoyle).

Family **SEPIIDÆ** Steenstrup, 1861.

Genus **SEPIA** Linné, 1758.

The tremendous development of the genus *Sepia*, both in species and number of individuals, is the most conspicuous feature of the cephalopod fauna of Japan, as it is likewise in the waters of the Indo-Malayan Archipelago. It is therefore not surprising to find that no less than eighteen names have at one time or another been applied to Japanese forms. These are as follows:

Sepia aculeata.
Sepia sinensis.[9]
Sepia chrysophtalmos.[10]
Sepia myrsus.[11]
Sepia andreana.
Sepia esculenta.
Sepia elliptica.
Sepia kobiensis.
Sepia andreanoides.
Sepia peterseni.
Sepia tullbergi [= *Metasepia*].
Sepia tokioensis.
Sepia hoylei.
Sepia torosa.
Sepia hercules.
Sepia lorigera.
Sepia misakiensis.
Sepia appellöfi.

[9] *Sepia sinensis* d'Orbigny, 1839, united by Gray with *S. inermis* (van Hasselt), is a name applied by d'Orbigny to a squid described in an article in the *Encyclopedie japonaise*. Although Tryon follows Gray, it seems doubtful if the species is in any way recognizable.

[10] *Sepia chrysophtalmos* Tilesius is a minute animal referred by d'Orbigny (1839, p. 324, *Loligopsis*, pl. 1, figs. 2–4, *fide* Hoyle) to *Loligopsis*, but probably impossible of determination.

[11] *Sepia myrsus* Gray (1849, p. 108) has been doubtfully listed in the Japanese fauna by Hoyle (1886, p. 219), but I know of no other reference to its actual occurrence there.

This list is somewhat reduced by the elimination of doubtful names, but even then contains many species which are not always easy to distinguish from one another and sometimes offer problems of great difficulty. The entire group is much in need of a painstaking and thorough revision at the hands of someone having access to a wealth of carefully preserved material, and when this time comes it is possible that several of the nominal species may be reduced to the rank of synonyms. A good many specimens have been available to the present writer, but the series have usually been too incomplete or, in the case of numerous market specimens, too poorly preserved to render accurate determination easy, much less afford ground for any important generalizations.

The majority of Japanese species belong to a rather well-defined group of narrow-shelled forms referred to by Wülker as the "*andreana*-Gruppe" and here for the sake of convenience recognized as a subgenus or section, to denominate which the term *Doratosepion* de Rochebrune has been rehabilitated. An excellent discussion of these forms together with a detailed key to the same has been given by Wülker (1910, pp. 17–20).

Sepia aculeata Van Hasselt MS., 1834.

Sepia aculeata Van Hasselt MS., in d'Orbigny and Férussac, 1834, p. 287, pls. 5, 25 (*fide* Wülker).
Sepia aculeata d'Orbigny, 1845, p. 296.
Sepia aculeata Gray, 1849, p. 105.
Sepia aculeata Steenstrup, 1875, p. 473, pl. 2, fig. 4.
Sepia aculeata Tryon, 1879, p. 195, pl. 90, fig. 415; pl. 91, figs. 416, 417 (after d'Orbigny).
Acanthosepion Hasselti de Rochebrune, 1884, p. 101.
Sepia aculeata Joubin, 1898, p. 25.
Sepia aculeata Wülker, 1910, p. 11.

A large ♂ specimen of this species having a dorsal mantle length of 21 cm. is entered as Cat. No. 2,045 in the Stanford University Invertebrate Series [S. S. B. No. 343]. It was obtained by Messrs. Jordan and Snyder at Tsuruga, Echizen. The locular index of the gladius of this specimen is 13.3.

Distribution.—Near Misaki, Sagami (Wülker); Tsuruga, Echizen (!). Java (d'Orbigny); Indian Ocean (Gray).

Sepia esculenta Hoyle, 1885.

Sepia esculenta Hoyle, 1885*b*, p. 188.
Sepia esculenta Hoyle, 1885*d*, p. 291.
Sepia esculenta Appellöf, 1886, p. 28, pl. 3, figs. 1–6.
Sepia esculenta Hoyle, 1886, pp. 129, etc., pl. 17, figs. 1–5; pl. 18, figs. 1–6.
Sepia esculenta Ortmann, 1888, pp. 649, 665.
Sepia esculenta Pilsbry, 1894, p. 144.
Sepia esculenta Hedley, 1906, p. 463.

A single ♀, entered as No. 2,046 of the Invertebrate Series,

Stanford University collections [S. S. B. No. 360], was obtained at Tokio by Jordan and Snyder. It much resembles the preceding species, but seems clearly referable to *S. esculenta* since it "lacks the suckers on the buccal membrane and also the callosity of the inner cone." Despite these differences, the two forms are very nearly allied.

Distribution.—Tokio (Ortmann, !); Yokohama Market (type locality, Hoyle); Nagasaki, Hizen (Appellöf). Queensland, Australia (Hedley).

Sepia Hercules Pilsbry. 1894.

Sepia hercules Pilsbry, 1894, p. 144.
Sepia hercules Pilsbry, 1895, p. 2, pl. 1, fig. 2.
Sepia hercules Wülker, 1910, pp. 11, 22, 24 (mere note).

Distribution.—Japan (Pilsbry); Loo Choo Islands (Pilsbry).

Sepia elliptica Hoyle, 1885.

Sepia elliptica Hoyle, 1885*b*, p. 189.
Sepia elliptica Hoyle, 1885*d*, p. 293.
Sepia elliptica Hoyle, 1886, pp. 22, 131, etc., pl. 19, figs. 14–24.
Sepia elliptica, Wülker, 1910, pp. 11, 23.

Distribution.—Near Misaki, Sagami (Wülker). Arafura Sea, south of Papua (type locality, Hoyle).

Sepia hoylei Ortmann, 1888.

Sepia hoylei Ortmann, 1888, p. 650, pl. 22, fig. 5; pl. 23, fig. 1.
Sepia elliptica (pars ?) Wülker, 1910, pp. 11, 22.

Wülker has suggested that this species may be identical with *S. elliptica* and infers that Ortmann may have been mistaken in the most important diagnostic character—the presence of teeth on the horny rings of the sessile arm suckers. I can, however, confirm Ortmann's observation. Suckers of a specimen from Nagasaki show about 35 small, short, broadly conical teeth, their tips squarish (or broken ?), developed with fair evenness all around. In all other respects also this material agrees well with the description of *S. hoylei*, but indicates that this form is at best so weakly differentiated from *S. elliptica* that the conclusion attained by Wülker may yet prove to be correct.

A specimen before me from Wakanoura is young and too poorly preserved for certain identification, but the gladius agrees well with the Nagasaki specimens.

Material Examined.—

No. Sp.	Locality.	Collector.	Where deposited.	Author's Register.
4	Nagasaki, Hizen	Jordan and Snyder	L.S.J.U., Cat. 2,047	356
? 1	Wakanoura, Kii	Jordan and Snyder	L.S.J.U., Cat. 2,048	379

Distribution.—Maizuru, Tango (Ortmann); Bay of Tokio (Ortmann); Enoshima, Sagami (Ortmann); Wakanoura, Kii (!); Kadsiyama (Ortmann); Kochi, Toza (Ortmann); Kagŏshima, Satsuma (Ortmann); Nagasaki, Hizen (!).

Sepia torosa Ortmann, 1888.

Sepia torosa Ortmann, 1888, pp. 652, 665, pl. 23, fig. 2.
Sepia torosa Ortmann, 1891, p. 674.

Distribution.—Bay of Tokio (type locality, Ortmann). Amboina (Ortmann).

Sepia formosana new species. Pl. IX, fig. 7.

Body wide, stout, compressed, semi-elliptical. Fins nearly one third as wide as the body, widest near the middle and becoming very narrow posteriorly though nearly continuous around the

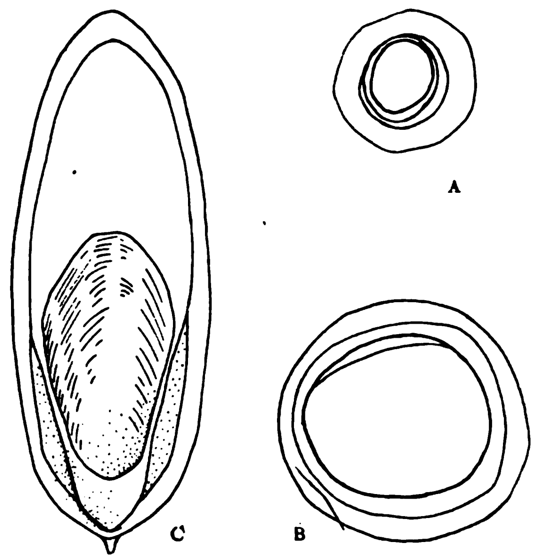


Fig. 2.—*Sepia formosana* [361]: *a*, camera outline of horny ring from third left arm, much enlarged; *b*, camera outline of horny ring of large tentacular sucker, same scale as preceding; *c*, ventral aspect of gladius, natural size.

extremity of the body. Mantle margin produced into a prominent rounded angle above, but truncate or slightly emarginate below.

Head broad, flattened. Eyes large, prominent. Funnel broad, truncate at the apex, the latter barely reaching the gap between the ventral arms.

Arms subequal, somewhat over a third as long as the body; all more or less compressed, the third and fourth pairs conspicuously

keeled. Membranes bordering the sucker-bearing area well developed. Suckers minute, cup-shaped, in four rows on all the arms; horny rings smooth. A narrow umbrella connects all the arms at the base.

Tentacles rather short, stout, the clubs very large. Suckers in about four to five rows; those of the two marginal series very minute, the median ones slightly larger and about six of the latter very much larger than any of the others, the three nearest the middle of the club being largest of all (Pl. IX, fig. 7). The latter have smooth horny rings while those of the smaller suckers seem to be very minutely denticulate or crenate.

Surface smooth throughout.

Color dull buff-gray, heavily mottled above and more lightly dotted below with blackish-slate-colored chromatophores.

Gladius elongate-elliptical in outline, a little over one-third as broad as long; chitinous margin quite wide and narrowly continuous posteriorly across the short stout straight spine. Dorsal surface finely rugose-granulose, the granules disposed in concentric series parallel to the anterior margin; two shallow converging grooves near the centre divide the shell into a narrow median and two wide lateral areas; the calcareous coating over the chitinous layer is very thin dorsally, especially near the edges. Ventral surface excavated posteriorly; the striated area occupies about half the length of the shell, but its extreme posterior portion is obscured by the heavy callous which strengthens the inner cone. The limbs of the callous arise near a point a little more than one-third the length of the shell from the posterior end. Locular index (inclusive of chitinous margin) about 43.

Type.—Cat. 2,049, Invertebrate Series, Stanford University Collections [S. S. B. No. 361].

Type Locality.—Takao, Formosa (Hans Sauter); one specimen.

Measurements.

	mm.
Tip of body to base of dorsal arms	82
Median length of mantle (dorsal)	72
Median length of mantle (ventral)	64
Width of mantle	37
Width of fin at widest point	11
Width of head	31
Length of funnel	26
Length of dorsal arm	35
Length of second arm	31

	mm.
Length of third arm	32
Length of ventral arm	34
Length of tentacle	45
Length of tentacle club	17
Diameter of largest tentacular suckers	3

Judging from the single specimen at hand (which, it must be confessed, is not in the best state of preservation), this little species approaches very closely to *S. torosa* Ortmann, but differs in (1) the decidedly more elongate outline of the body, (2) the smooth horny rings of the sessile arm suckers, and (3) the even more conspicuous enlargement of certain suckers on the tentacle club (decidedly more than "noch einmal so gross wie die übrigen"). The locular index of the gladius is about the same, unless in calculating it we exclude the chitinous margin, in which case the index is but about 37. The calloused area is, however, relatively greater.

Other allied forms appear to be *S. rouxii* d'Orbigny (Indo-Malayan), *S. microcotyledon* Ortmann (Ceylon), and possibly the Chinese *S. sinope* Gray, the two latter of which have been discussed by Ortmann (1891, p. 674). *S. microcotyledon* is the only one described as having smooth horny rings, but here the structure of the tentacle club is very different.

Curiously enough, I have been unable to discover any records of cephalopods from Formosa in any of the literature. Although my search may not have been exhaustive, it is probable that the three species here recorded (*Sepia formosana*, *Euprymna morsei*, and *Sepioteuthis lessoniana*) are the first species to be accredited to the island.

Sub-genus DORATOSEPION (de Rochebrune, 1884).

Sepia (Doratosepion) lorigera Wülker, 1910.

Sepia lorigera Wülker, 1910, p. 12, pl. 2, figs. 3, 4; pl. 3, figs. 11–14.

Distribution.—Near Misaki, Sagami (type locality, Wülker).

Sepia (Doratosepion) andreana Steenstrup, 1879.

Sepia Andreana Steenstrup, 1875, pp. 474, 479, pl. 1, figs. 11–19.
Sepia Andreana Tryon, 1879, p. 193, pl. 89, fig. 408; pl. 90, figs. 409, 410 (after Steenstrup).
Doratosepion andreana de Rochebrune, 1884, p. 96.
Sepia andreana Ortman, 1888, pp. 662, 665.
Sepia andreana Wülker, 1910, pp. 19, 22, 24.

Distribution.—Japan (Steenstrup).

Sepia (Doratosepion) peterseni Appellöf, 1886.

Sepia Peterseni Appellöf, 1886, p. 23, pl. 2, figs. 1–6; pl. 3, fig. 21.
Sepia peterseni Ortmann, 1888, pp. 663, 665.
Sepia peterseni Wülker, 1910, pp. 14, 19, 24.

Distribution.—Tokio Market (Wülker); near Misaki, Sagami (Wülker); Nagasaki, Hizen (type locality, Appellöf).

Sepia (Doratosepion) andreanoides Hoyle, 1885.

Sepia andreanoides Hoyle, 1885*b*, p. 193.
Sepia andreanoides Hoyle, 1885*d*, p. 297.
Sepia andreanoides Hoyle, 1886, pp. 139, etc., pl. 21, figs. 11–19; pl. 22, fig. 11.
Sepia andreanoides Ortmann, 1888, pp. 653, 665.
Sepia andreanoides Wülker, 1910, pp. 19, 22, 24.

Distribution.—Bay of Tokio (Ortmann); Yokohama Market (type locality Hoyle).

Sepia (Doratosepion) kobiensis Hoyle, 1885.

Sepia kobiensis Hoyle, 1885*b*, p. 195.
Sepia kobiensis Hoyle, 1885*d*, p. 300.
Sepia kobiensis Appellöf, 1886, p. 20, pl. 3, fig. 7.
Sepia kobiensis Hoyle, 1886, p. 142, pl. 18, figs. 7–14.
Sepia kobiensis Ortmann, 1888, pp. 654, 665.
Sepia kobiensis Hoyle, 1905, p. 982 (locality record).
Sepia kobiensis Wülker, 1910, pp. 16, 20, 24.

This is one of the most abundant Japanese species, but the condition of the material is such that I am in some doubt as to whether all of the following specimens are properly referred to it.

No. Sp.	Locality.	Collector.	Where deposited.	Author's Register.
13	Nagasaki, Hizen	Jordan and Snyder	L.S.J.U., Cat. 2,051	349
1	Hakodate, Hizen	Jordan and Snyder	L.S.J.U., Cat. 2,050	357
4	Hakodate, Hizen	Jordan and Snyder	L.S.J.U., Cat. 2,050	359

Distribution.—Bay of Tokio (Ortmann); Misaki, Sagami (Wülker); Kobe, Settsu (type locality, Hoyle); Kadsiyama (Ortmann); Kagoshima, Satsuma (Ortmann); Nagasaki, Hizen (Appellöf, !); Hakodate, Hizen (!); Maizuru, Tango (Ortmann).

Kolumadulu Atoll, South Pacific (Hoyle).

Sepia (Doratosepion) tokioensis Ortmann, 1888.

Sepia tokioensis Ortmann, 1888, pp. 653, 665, pl. 23, fig. 3.
Sepia tokioensis Wülker, 1910, pp. 14, 20.

Three specimens taken by Jordan and Snyder at Aomori are perhaps to be referred to this species (Invertebrate Series Cat. No. 2,052, Stanford University Collections).

Distribution.—Aomori, Mutsu (!); Bay of Tokio (type locality, Ortmann); near Misaki, Sagami (Wülker).

Sepia (Doratosepion) misakiensis Wülker, 1910.

Sepia misakiensis Wülker, 1910, p. 15, pl. 1, figs. 5, 6; pl. 3, figs. 19, 22.

Distribution.—135 meters' depth, off Misaki, Sagami (type locality, Wülker).

Sepia (Doratosepion) appellöfi Wülker, 1910.

Sepia appellöfi Wülker, 1910, p. 14, pl. 1, fig. 8; pl. 3, figs. 15–18.

Distribution.—Near Misaki, Sagami (type locality, Wülker).

Genus **METASEPIA** (Hoyle, 1885).

Metasepia tullbergi (Appellöf, 1886).

Sepia Tullbergi Appellöf, 1886, p. 26, pl. 2, figs. 7–14.
Sepia (Metasepia) tullbergi Ortmann, 1888, pp. 656, 665.

Distribution.—Kadsiyama (Ortmann); Kagoshima, Satsuma (Ortmann); Nagasaki, Hizen (type locality, Appellöf).

Genus **SEPIELLA** (Gray, 1849).

Sepiella inermis (Van Hasselt MS., 1839) Steenstrup, 1880.

Sepia inermis Van Hasselt MS., in d'Orbigny and Férussac, 1839, p. 286, pl. 6, bis; pl. 20, figs. 1–9 (*fide* Hoyle).
Sepia inermis d'Orbigny, 1845, p. 295, pl. 12, figs. 9, 10.
Sepia microcheirus Gray, 1849, p. 107.
Sepia inermis Tryon, 1879, p. 196, pl. 91, fig. 423; pl. 92, figs. 424, 425.
Sepia inermis Steenstrup, 1875, p. 478, pl. 2, fig. 3.
Sepiella inermis Steenstrup, 1880*a*, pp. 347–356, figs. 1–8.
Sepiella inermis Joubin, 1897*a*, p. 103.
Sepiella inermis Joubin, 1898, p. 25.
Sepiella inermis Hoyle, 1905, p. 982, fig. 152.

Distribution.—Japan (Joubin). Timor (Joubin); Batavia, Java (d'Orbigny); Male Atoll (Hoyle); Pondicherry (d'Orbigny); Coromandel (d'Orbigny); Bombay (d'Orbigny).

Sepiella maindroni de Rochebrune, 1884.

Sepiella Maindroni de Rochebrune, 1884, p. 89.
Sepiella maindroni (?) Hoyle, 1886, pp. 26, 149, etc., pl. 22, figs. 1–10.
Sepiella maindroni Ortmann, 1888, pp. 663, 665 (merely listed).
Sepiella maindroni Wülker, 1910, pp. 20, 23.

Distribution.—Tokio Market (Wülker); near Aburatsubo, Sagami (Wülker); Inland Sea (Hoyle). Pondicherry (type locality, de Rochebrune).

Division ŒGOPSIDA d'Orbigny, 1839.

Family **GONATIDÆ** (Hoyle, 1886).

Genus **GONATUS** Gray, 1849.

Gonatus fabricii (Lichtenstein, 1818) Steenstrup, 1880.

Onychoteuthis Fabricii Lichtenstein, 1818, p. 13 (*fide* Hoyle).
Onychoteuthis Kamtschatica Middendorff, 1849, p. 515, pl. 12, figs. 1–6.
Gonatus Fabricii Steenstrup, 1881*a*, p. 9, pl. 1.
Gonatus fabricii Pfeffer, 1900, p. 163.
Gonatus fabricii Berry, 1912, p. 308, pl. 52, figs. 1–4; pl. 53; pl. 54, figs. 1–4; pl. 55.

I have already given a full bibliography of this widely distributed

species in the paper cited. It has been reported from Shumshu Island, Kurile Group, by Middendorff, and from Japan without more definite locality by Steenstrup. It probably inhabits the whole northern part of the archipelago.

Family **ENOPLOTEUTHIDÆ** Pfeffer, 1900.

Sub-family ENOPLOTEUTHINÆ Chun, 1910.

Genus **ABRALIOPSIS** Joubin, 1896.

Abraliopsis scintillans Berry, 1911. Pls. VII, VIII; pl. IX, figs. 1–6.

? *Abraliopsis* sp. Nishikawa 1906*a*, p. 310 (eggs).
Abraliopsis scintillans Berry 1911*a*, p. 93.

Animal small, loliginiform; the mantle thin, cylindrical in front; slender and tapering rapidly to an acute point posteriorly. Fins very large, broadly sagittate, over three-fifths as long as the mantle, their total width at the point of greatest expansion about the same as the length; forward margins arcuate, descending abruptly inward from a nearly right angle anteriorly; angles of lateral margins rounded, a little less than right, well anterior of the middle; hinder margins concave, produced posteriorly to an acute point. Anterior mantle margin slightly produced to form an obtuse median point above and a lateral angle on either side of the funnel.

Head large, flattened, excavated beneath. Eyes enormous, rounded and frequently much protruding in preserved specimens; ocular apertures large, with a distinct sinus in front. Funnel broad, compressed, little projecting; interior with a pocket-like valve near the tip; funnel organ comprising a large Λ-shaped median pad, with notably expanded limbs posteriorly situated on the dorsal wall, and two ovate ventro-lateral cushions (Pl. IX, fig. 5).

Each funnel-locking cartilage a large elongate-ovate plate, deeply excavated down the centre, the elevated margin conspicuously reflected, its cavity corresponding with a simple linear groove about 8 mm. long on the inner surface of the mantle.

Arms of moderate length, nearly equal, the order of length in general 4, 3 = 2, 1, though the third pair is sometimes a little longer than the second. In detailed structure the arms differ considerably; for the sake of more accurate observation, those of the left side of one specimen were removed and have furnished the following account. Dorsal arm armed with 12 small stout hooks in two alternating rows, replaced by numerous minute suckers in two series at the extremity; on the outer margin along the whole length, except at the extreme base, is a broad colorless keel, widest below the middle of

the arm; along the ventral margin of the sucker-bearing area is a delicate hyaline swimming membrane supported by a series of fleshy lappets about equal in longitude to the hooks opposite which they lie. Second arm also with 12 hooks (though on the right second arm of another specimen 14 hooks were counted) and otherwise in all essentials like the first. The third arm likewise has 12 hooks succeeded by minute suckers at the tip; it is, however, more robust than any of the others; a very broad conspicuous hyaline membranous keel, unadorned with chromatophores on either surface, runs along the outer margin, at its widest point (near the middle) exceeding the diameter of the arm itself; ventral margin furnished with a hyaline swimming membrane as above, but its trabeculæ are much longer and larger. Ventral arm (Pl. IX, fig. 4) with 11–12 hooks and no suckers, the whole extremity of the arm being bare except for the curious terminal organs described below; longer and more gradually tapering than the other arms, the hooks slightly smaller; devoid of swimming membranes, but there is a well-developed keel along the outer (dorsal) angle; the tip of each ventral arm is occupied by a longitudinal series of three large, ovoid, heavily pigmented, bead-like organs of a blackish color succeeded distally by one or two minute rudiments of similar structures where the tip of the arm suddenly tapers to a point; these are little protruding and have the superficial appearance of being enveloped within the substance of the arm itself, though really enclosed in the integument on the side of the latter; in size the central organ perhaps slightly surpassing the others (Pl. IX, fig. 1).

As all the specimens seen are females, the hectocotylized arm and other sexual characters have not been observed.

Tentacles slender, about the length of the mantle, sides compressed and somewhat flattened, inner surface of stalk flattened. Clubs little or not at all expanded, the distal two-thirds armed with four distinct crowded rows of minute suckers, some 74 to 76 in all,[12] regularly diminishing in size toward the tip; proximal to these and projecting well out beyond the ventral margin are two very large, elongate, slender, strongly incurved, sharply pointed hooks projecting for some distance from their large fleshy bases; opposite these along the dorsal margin a single series of exceedingly minute short-pediceled suckers, usually four in number and apparently

[12] Cf. the figure given by Chun of *A. morisii* ♀ (1910, pl. 8, fig. 3), where but about 40 such suckers are shown occupying a relatively much smaller proportion of the entire club.

homologous with the most marginal row of the distal suckers; proximal to the hooks and in a line with them on the right tentacle club is usually situated a single minute sucker similar to those just described. Certain variations occur, as (*e.g.*) in the club from which the accompanying figure (Pl. IX, fig. 6) was drawn; here the small suckers opposite the hooks were apparently wanting (through abrasion ?) and were supplied in the drawing from another specimen. The general character and extent of these variations are well brought out in the accompanying table of data taken from all the specimens examined and would seem to indicate that where the number of minute suckers is fewer than that above regarded as typical, it may be due to the facility with which such delicate structures may be lost by abrasion.

Tentacle.		No. of large hooks in ventral row.	No. suckers proximal to hooks in ventral row.	No. suckers opposite to hooks in dorsal row.	No. suckers in fixing apparatus.	No. pads in fixing apparatus.	Arrangement of fixing apparatus.
1	Right	2	1	5	4	4	Compact.
	Left	2	0	4	4	4	"
2	Right	2	1	4	4	4	"
	Left	2	0	......	4	4	"
3	Right	......	.. ...	......	......	.... .	......
	Left	2	0	0	4	4	Diffuse.
4	Right	2	0	4	4	4	Compact.
	Left	2	0	3	4	4	Diffuse.
5	Right	2	1	4(+1?)	4	4	Medium.
	Left	2	0	2(+?)	4	4	Compact.
6	Right	2	0	4[13]	3	3	Medium.
	Left	2	0	3	3	3	Compact.

Fixing apparatus well developed and with one exception very constant in comprising four minute suckers and four pads regularly alternating in two rows; sometimes these are relatively distant as in the figure, but often more compactly grouped. The distal (sucker-bearing) part of the club is furnished with a membranous keel along its dorsal margin (Pl. IX, fig. 6).

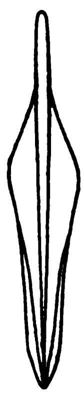
Buccal membrane eight-pointed, papillose within; its color deep violet, the supporting lappets of a conspicuously paler shade outwardly.

Gladius (fig. 3) with broad wings, embracing the slender midrib for quite three-quarters of its length; only slightly subangulate laterally at the point of widest expansion. Keel plainly visible through the dorsal integument as a dark median line.

[13] Here a small sucker is also present between this row and the proximal hook.

Radula not examined.

Integument with numerous minute photogenic organs, appearing as dark bluish dots having a distinctly paler centre. These are distributed as follows: (1) on the ventral surface of the mantle they are everywhere exceedingly numerous and so evenly distributed that a bilateral arrangement is only apparent after close examination, being even then not at all absolute; definite rows indistinguishable except for a narrow but distinct and fairly conspicuous area entirely free of photophores and forming a straight longitudinal band down the medio-ventral line with a fairly constant width of scarce more than a millimeter throughout its course; the number of photophores in one of the rows bordering it is from 42 to 45. Laterally, the organs rapidly scatter and diminish in size until they



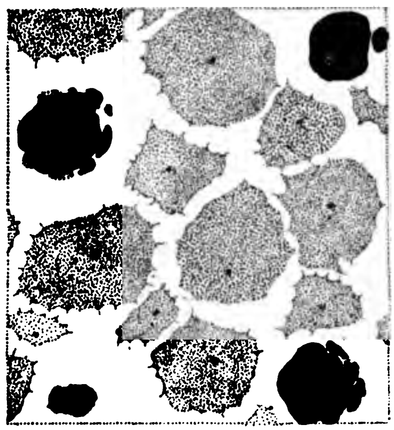


Fig. 3.—*Abraliopsis scintillans*, dorsal aspect of gladius, natural size; [147].
Fig. 4.—*Abraliopsis scintillans*, portion of integument from ventral surface of mantle seen by reflected light, showing photophores and chromatophores; from an unstained mount in balsam; greatly enlarged; [147].

are only with difficulty to be made out at all. However, I have been unable to find that they extend very much past the level of the eyes.

2. On the ventral aspect of the funnel the photogenic organs are similar in character to those of the mantle, but are fewer in number and therefore appear more symmetrically disposed. They are ranked in about ten poorly defined longitudinal rows, variously distant and containing 3–4 organs each, but the arrangement of the two lateral halves is alike and here again they are separated by a clear space down the middle.

3. On the ventral surface of the head the photophores have evidently a primary arrangement in longitudinal series, but this has become so modified by the interpolation of various shorter series and isolated organs that the exact number of rows is difficult to determine. Most apparent are (*a*) the usual median row which bifurcates at the apex of the funnel groove and at the base of the ventral arms, along which latter its two branches continue for the proximal two-thirds of their length: (*b*) a long lateral series beginning on the ventral fold of the olfactory crest which curves inward on the head and also continues out the ventral arms to their extremities; (*c*) a very distinct circlet of more ovoid organs surrounding the ocular aperture (Pl. IX, fig. 2).

4. The ventral arms as just noted have two rows of photophores upon the arm itself, and in addition a distinct row of 7–8 small very distant organs along the outer margin of the keel. The third arms have but a single row of 4–5 organs along their ventral aspect. On the remaining arms, on the tentacles, and on the dorsal surface of the head no luminous organs were observed.

In addition to the photogenic organs of the general integument and the curious pigmented structures already described at the tips of the ventral arms, there is a third very distinct type of photophore in the form of a series of small circular bead-like bodies, brownish-orange in color, on the ventral periphery of the eyeball; these are five in number, the three central ones smallest and interspaced from one another about a millimeter; the two terminal ones are each distant about 1½ mm. from the neighboring organ and their diameter is about twice as great (*i.e.*, rather less than a millimeter) (Pl. IX, fig. 3). These organs, though situated on the eyeball itself, are usually visible even when the latter is closely retracted, because of a small ovate hyaline non-pigmented area in that portion of the ventral integument which normally covers them. When, as sometimes occurs, this area is iridescent and a little distended, it becomes quite conspicuous. Its purpose is obviously to allow the rays of light from these organs to pass through the outer integument with as little obstruction as possible.

Color in life not observed; in alcoholic specimens the ground color is a pale brownish-buff, dotted over nearly the entire surface with small and very beautiful reddish-brown chromatophores, which are especially numerous and darkest just above the keel of the gladius, but thickly scattered, even on the ventral surface where they are very conspicuous among the bluish photophores. On

the under sides of the fins, the hyaline area above described, the inner surfaces of the arms, and the keels of the three dorsal pairs the skin is nearly or entirely free of chromatophores. Because appearing with unusual constancy, a single large chromatophore, surrounded by a circlet of smaller ones and situated on the head just posterior to the crotch between the dorsal arms, is also probably worthy of mention. The lens of the eye is large, spherical, and exquisitely pearly.

Measurements.

Author's register	147			279		
Specimen number	1	2	3	4	5	6
	mm.	mm.	mm.	mm.	mm.	mm.
Length, total	132	119	......	125	117	123
Length, exclusive of tentacles	95	91	86	97	93	98
Length of mantle, dorsal	59	55	52	60	57	55
Width of mantle	16	15	13	15	14	17
Width across fins	38	38	37	45	40	46
Length of fins, total	39	36.5	34	38	35	38
Length of fins along plane of attachment	33.5	33	30	33	30	32
Width across head	17	18	17	15	13	15
Width between eyes	8	7	7.5	9	7	8
Length of head, dorsal	12	11	12	11	11	12
Length of right dorsal arm	19	17	19	23	22	22
Length of left dorsal arm	21	18	20	22	22	22
Length of right second arm	22	23	22	25	26.5	25
Length of left second arm	22	23	22	25	25	26
Length of right third arm	23	23	22	25	24	25
Length of left third arm	24	23	23	25	25	25
Length of right ventral arm	26	28	26	28	28	31
Length of left ventral arm	27	24	......	27.5	28	31.5
Length of right tentacle	59	55	......	56	52	56
Length of left tentacle	65	51	......	53	48	55
Length of tentacle club	7	7	......	7	7	7.5
Length of funnel	......	......	9	......	......	......

Type.—Cat. No. 2,053. Invertebrate Series, Stanford University collections [S. S. B. No. 147]; a female.

Type Locality.—Japan, probably off Misaki (Alan Owston ?); three ♀ specimens.

Material Examined.—In addition to the three cotypes, three other specimens, taken at Misaki by Ishikawa [S. S. B. No. 279], have been examined. All six are females. In the tables they have been numbered, respectively, 1–3 and 4–6, and the specimens denoted as Nos. 3 and 5 have been destroyed by dissection.

Remarks.—This beautiful little squid was originally described from three individuals in the Stanford University collections thought to be from Japan, but in reality of quite uncertain origin. This habitat was, however, confirmed in a most interesting manner, almost immediately upon the preparation of the original diagnosis, by the receipt through the kindness of Dr. Harold Heath of three "squids with luminous dots," sent to him from Japan by Dr. Ijima. These were the specimens mentioned above from Misaki and proved to be identical in every essential feature with the types, entirely confirming in every particular the characters which I had depended upon as diagnostic. Both the Stanford specimens and those sent by Dr. Ijima are beautifully preserved, are nearly of the same size, and apparently fully grown. One of the largest, if not the largest species of the genus, *A. scintillans*, is differentiated from the previously described forms in the following apparently constant characters:

1. The great number of photophores on the ventral surface and the comparative obscurity of their bilateral arrangement as well as the absence of distinct longitudinal series.

2. The presence of only one row of hooks (the ventral) on the tentacle club, with but two elements present even here.

3. The replacement of the dorsal row of hooks present in other species by a single or slightly zigzag series of minute suckers.

4. The large number of suckers in the four distal rows on the club and the fact that these occupy nearly two-thirds of the total length.

5. The usual presence of four suckers and four pads in the fixing apparatus.

6. The detailed structure of the sessile arms which appears to differ constantly from the careful account given by Hoyle (1904, p. 37) in regard to *A. hoylei*.

With these features in mind, it is by no means difficult to separate *A. scintillans* from either the Atlantic *A. pfefferi* or the *A. hoylei* of the South and East Pacific,[14] with both of which it is, however, closely allied. It is to be expected that any structure so complex

[14] Chun, in a recent monograph (1910, p. 78), unites both of these forms under the earliest name applied to a member of the genus, *A. morisii* Vérany, 1837, and gives a large number of exquisitely beautiful figures of a series supposed to be identical. The evidence offered is certainly suggestive, but does not appear to the present writer to be conclusive proof that we have but a single cosmopolitan species of *Abraliopsis*, however closely related otherwise the various forms may be.

as the armature of the tentacle club should be subject to a considerable degree of variation among its constituent elements, so that its great constancy in the present series is really quite surprising and indicates that it may prove especially important in distinguishing species. The discovery of males of this species should throw an interesting light upon the entire subject.

In gross aspect and general outline of the body there is great variation, depending upon the conditions of preservation. The greatest individualities observed are in the form of the mantle. Sometimes the outline tapers smoothly and regularly from the anterior margin, or there may be a pronounced bulging near the middle, or sometimes a general inflation of the whole.

Genus **THELIDIOTEUTHIS** Pfeffer, 1900.

Thelidioteuthis alessandrinii (Vérany, 1851) Chun, 1910.

Loligo Alessandrinii Vérany, 1851, p. 99, pl. 35, figs. f, g, h (*fide* Chun).
Enoploteuthis polyonyx Troschel, 1857, p. 67, pl. 4, fig. 9.
Thelidioteuthis polyonyx Pfeffer, 1900, p. 167.
Thelidioteuthis Alessandrinii Chun, 1910, p. 104, pl. 7, figs. 16, 17.

A specimen in the possession of the writer from the Gulf of Kagoshima appears to be a young individual of this widely distributed species, though it is possible that the adult might show differences worthy of separate recognition. [S. S. B. No. 274.]

Distribution.—Gulf of Kagoshima (!). Mediterranean; South Atlantic (Pfeffer); Indian Ocean (Chun); Society Islands (Pfeffer).

Family **OCTOPODOTEUTHIDÆ** new name.
(= *Veranyidæ* Chun, 1910.)

Genus **OCTOPODOTEUTHIS** Rüppell, 1844 (em.).

Octopodoteuthis sp.

Octopodoteuthis near *O. sicula* Chun, 1910, p. 139.

In the work cited Chun mentions a specimen of this genus taken by Döflein in Sagami Bay.

Family **HISTIOTEUTHIDÆ** Verrill, 1881.

Genus **CALLITEUTHIS** Verrill, 1880.

Calliteuthis ocellata (Owen, 1881) Verrill, 1881.

Loligopsis ocellata Owen, 1881, p. 139, pl. 26, figs. 3–8; pl. 27.
Calliteuthis ocellata Verrill, 1881, p. 402.
Calliteuthis ocellata Verrill, 1882, p. 412 [202].
Calliteuthis reversa Hoyle, 1886, p. 183, pl. 33, figs. 12–15 (not of Verrill).
Calliteuthis reversa (pars) Pfeffer, 1900, p. 170.
Calliteuthis reversa (pars) Chun, 1906, p. 744.
Calliteuthis ocellata Chun, 1910, pp. 149, 170, etc., Texttafel 1, figs. 1, 2; text figs. 22, 23; pl. 20, figs. 7–9.

The true *Calliteuthis reversa* Verrill is not yet known to be a member

of the Japanese fauna. Assuming the correctness of the recent careful synopsis of the genus given by Chun (1910), the various references to it in the literature cited have certainly been based upon misidentifications.

Distribution.—Sagami Bay (Chun); 345 fathoms, off Ino Sima Island (Hoyle); China Sea (type locality, Owen).

Family ARCHITEUTHIDÆ Pfeffer, 1900.

Genus ARCHITEUTHUS Steenstrup, 1856.

Architeuthus martensii (Hilgendorf, 1880) Steenstrup, 1882.

Megateuthis Martensii Hilgendorf, 1880, p. 65.
Architeuthus Martensii Steenstrup, 1882, p. 157 [15].
Architeuthis, sp. Mitsukuri and Ikeda, 1895, pp. 39–50, 1 pl. (*fide* Hoyle).

Distribution.—Japan (Hilgendorf).

Family OMMASTREPHIDÆ Gill, 1871.

Genus OMMASTREPHES d'Orbigny, 1835.

Ommastrephes sloanii Gray, 1849. Pl. VI, fig. 4.

Ommastrephes Sloanii Gray, 1849, p. 61.
Ommastrephes Sloanii Tryon, 1879, p. 180 (after Gray).
Todarodes pacificus Steenstrup, 1880, pp. 83, 90, etc. (*fide* Hoyle).
——(?) *Sloanei* Steenstrup, 1880, p. 98.
Ommastrephes sloanei Verrill, 1881, p. 386 (brief note).
Ommastrephes pacificus Appellöf, 1886, p. 35, pl. 3, figs. 8–10.
Todarodes pacificus Hoyle, 1886, pp. 34, 163, 219, pl. 28, figs. 1–5.
Todarodes pacificus Ortmann, 1888, pp. 664, 665 (merely listed).
? *Ommastrephes gouldi* M'Coy, 1888.
? *Ommastrephes gouldi* Brazier, 1892, p. 17 (locality record).
Todarodes pacificus Joubin, 1897*a*, p. 103.
not ? *Ommastrephes sloanei* Schauinsland, 1899, p. 92 (mere note).
Ommatostrephes sagittatus sloanei Pfeffer, 1900, p. 179.

[Pfeffer also unites with this species the *O. insignis* of Gould, 1852, ascribed to the Fiji Islands and the Antarctic region.]

Body elongate, cylindric, tapering posteriorly to a sharp point between the fins. Mantle margin entire above and but little emarginate below. Fins broadly sagittate, in the adult a little more than two-fifths as long as the mantle. Mantle connectives as usual in the group.

Head rather small, squarish, but much compressed, considerably narrower than the widest expansion of the body; bounded posteriorly by a transverse thickened ridge, continuous with the three oblique ear-like folds behind each eye. Eyes large, the wide lid openings with a narrow incision or sinus in front. Funnel groove with a distinct foveola in its anterior portion, comprising a horseshoe-

shaped fold of membrane embracing between its arms a series of 8–10 shorter and more fleshy longitudinal folds.

Arms moderate, squarish, fairly attenuate, averaging about half as long as the mantle; unequal, the order of length almost always 2, 3, 1, 4, although there are occasionally slight variations from this formula. Umbrella lacking, but the outer angles of all the arms equipped with a firm fleshy keel especially developed on the basal half of the third pair, and a delicate trabeculated swimming membrane, which is least evident on the ventral arms and widest on the ventral margin of the third pair. Suckers decidedly small (Pl. VI, fig. 4); rather distantly placed at the base in two regularly alternating rows, becoming more crowded at the tip; the interspacing between the rows very variable, apparently dependent mainly upon the degree of compression of the arms; suckers of the lateral arms slightly, but not at all conspicuously larger than those of the dorsal and ventral pairs; on an arm of the second pair some 56 to 60 suckers can readily be counted without using a lens. Horny rings well developed, their lower margins ordinarily smooth, but with 9 to 12 stout acute teeth, accompanied by occasional intervening denticles on the upper edge; these teeth are largest at the apex, but the median one is not particularly differentiated in this respect more than its neighbors.

Tentacles stout, moderate; the club slightly expanded, its sucker-bearing portion including about 60–65% of the total length in the adult (55–71%, according to Pfeffer); in general structure entirely similar to *O. hawaiiensis*,[15] the horny rings of the large median suckers armed with about 17 rather short, stout, acute, subequal teeth, occurring in regular alternation with an equal number of very low squarish plates, both teeth and plates being more regular, though somewhat more weakly developed than in *O. hawaiiensis*. A small sucker of the marginal rows shows about 18 acute teeth, larger and longer on the upper margin where they are accompanied by a few alternating denticles.

In young specimens, such as No. 273, the body appears more slender and the fins much shorter, both in proportion to the mantle length and their own width.

The chief measurements of eight specimens are given in the following table:

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[15] *Ommastrephes hawaiiensis* new species: A Hawaiian form closely allied to *O. sloanii* (*i.e.*, *pacificus*), but with much larger and fewer suckers on the sessile arms of the adult and with the central upper tooth of the horny rings distinctly larger than any of the others.

Measurements.

Author's register number	[286] mm.	[258] mm.	[257] mm.	[257] mm.
Length, total	393	332	329	316
Length, exclusive of tentacles	310	263	277	279
Length of mantle, dorsal	168	164	159	170
Width of mantle, median	50[16]	28	42[16]	35
Width across fins	111	80	95	87
Length of fins, total	78	66	67	67
Length of fins along plane of attachment	72	62	58	62
Length of head	37	23	24	24
Width of head	33	22	26	32
Length of right dorsal arm	101	67	79	72
Length of right second arm	113	74	97	85
Length of right third arm	111	68	91	85
Length of right ventral arm	90	63	71	67
Length of right tentacle, total	205	135	149	118
Length of right tentacle, sucker-bearing portion	125	81	91	74
Length of left tentacle, total	202	152	138	120
Length of left tentacle, sucker-bearing portion	123	90	86	78

Author's register number	[257] mm.	[257] mm.	[257] mm.	[273] mm.
Length, total	301	292	279	83
Length, exclusive of tentacles	253	256	250	73
Length of mantle, dorsal	155	161	156	45
Width of mantle, median	31	42[16]	34	10[16]
Width across fins	81	84	77	19
Length of fins, total	64	69	66	12
Length of fins along plane of attachment	59	63	59	11.5
Length of head	21	22	25	8
Width of head	21	31[16]	22	10
Length of right dorsal arm	66	66	62	17
Length of right second arm	78	77	75	19
Length of right third arm	75	77	70	18
Length of right ventral arm	60	66	60	14
Length of right tentacle, total	126	111	106	31
Length of right tentacle, sucker-bearing portion	83	71	67	17
Length of left tentacle, total	123	111	106	27
Length of left tentacle, sucker-bearing portion	81	71	68	14

[16] Badly compressed dorso-ventrally.

Type.—Of *sloanii*, in the British Museum; of *pacificus*, in the Copenhagen Museum.

Type Locality.—Of *sloanii*, Waitemata, New Zealand (Gray); of *pacificus*, Hakodate, Japan (Steenstrup).

Distribution.—Tomakomai, Iburi (!); Todohokke, Oshima (Wülker); Hakodate, Oshima (Steenstrup, !); Tokio (!); Misaki, Sagami (Wülker, !); Aburatsubo, Sagami (Wülker); Inland Sea (Hoyle); Nagasaki, Hizen (Appellöf). Vladivostok (Joubin); Indian Ocean (Gray); Victorian Water, South Australia (Brazier, as *O. gouldi*); Tasmania (Verrill); Waitemata, New Zealand (Gray).

Material Examined.—

No. Sp.	Locality.	Collectors.	Where deposited.	Author's Register.
1	Tomakomai, Iburi	J. O. Snyder	L.S.J.U., Cat. 2,057	273
2	Hakodate, Oshima	J. O. Snyder	L.S.J.U., Cat. 2,056	258
9	Hakodate, Oshima	Jordan and Snyder	L.S.J.U., Cat. 2,055	257
1	Tokio	Jordan and Snyder	L.S.J.U., Cat. 2,058	256
1	Misaki, Sagami	Jordan and Snyder	L.S.J.U., Cat. 2,059	259

Under the name *Ommastrephes Sloanii*, J. E. Gray in 1849 published the description of a species of squid from New Zealand belonging to the typical group of the genus and having probable relationship with *O. sagittatus*.[17] Subsequently Steenstrup (1880) erected a new species of his genus *Todarodes* (= *Ommastrephes* s. s.) for the reception of an apparently very similar cephalopod in the Copenhagen Museum from Hakodate, his description being supplemented by Hoyle with further interesting notes in the Challenger Report (1886) and a very excellent series of figures which fix the identity of the

[17] "*Ommastrephes Sloanii.*

"Body cylindrical, rather tapering behind. Fin rhombic, rather more than one-third the length of the body. Sessile arms compressed; cups equal, oblique, in two rows; rings black, higher side with regular acute teeth, lower smooth; third pair acutely finned, with a narrow, rayed, membrane on the inner edge of the ventral side. Tentacular arms slightly keeled externally, base half-naked; cups of lower part small, in two rows, of middle four rows, the seventh pair of the central series largest; rings with distant teeth all round; of the lateral series small, longly peduncled, and very oblique; of the apical portion small, in three or four rows, the smallest one nearly sessile." (Gray, 1849, p. 61.)

form intended beyond any manner of doubt. It is interesting to observe that Steenstrup himself affirms entire ignorance of the true generic position of *O. sloanii*, although Hoyle in the work cited referred it doubtfully to *Todarodes*. More recently Pfeffer (1900) has come to the conclusion that the two forms are identical and has, moreover, reduced them to subspecific rank under the Atlantic *O. sagittatus*. If these premises are correct, the rejection of the name *pacificus* in favor of the prior *sloanii* follows as a matter of course, an arrangement which has since been followed by Hoyle (1909) and by Wülker (1910), and is therefore adopted in this paper. To the present writer, however, this interpretation does not appear by any means conclusive. In the first place, the description of Gray when judged by modern standards is at best incomplete, and an examination of his type or even of further South Pacific material may yet reveal that he overlooked characters of sufficient importance to delimit this race from the Japanese form as completely as the latter now appears to be separated from its Mid-Pacific (Hawaiian) congeners. In the same connection another small item of evidence should not be overlooked: so careful an observer as Verrill (1881, p. 386) relates that a Tasmanian specimen referred by him to *O. sloanii* lacks the foveola at the apex of the funnel groove so characteristic of *O. sagittatus*, *pacificus*, and *hawaiiensis*. In any case, the specimens now before me are most certainly identical with the true *O. pacificus* as described and figured by Steenstrup and Hoyle, whether the latter eventually prove distinct from *sloanii* or not.

A key to the various known races of typical *Ommastrephes*, constructed on the same general plan as that utilized by Pfeffer, is accordingly offered as follows:

Sucker-bearing portion of the tentacle comprising more than $\frac{3}{4}$ of the total length (Atlantic species) .... *sagittatus*.
Sucker-bearing portion of the tentacle comprising distinctly less than $\frac{3}{4}$ of the total length (Pacific species) 1

1. Median upper tooth of the horny rings of the suckers on the sessile arms obviously the largest .... *hawaiiensis*.
   No single tooth of the horny rings noticeably larger than the others .... *sloanii*

Most recent authors follow Pfeffer in regarding *sloanii* as a subspecies of *sagittatus*, but despite the small differences I cannot see that anything is to be gained by the use of the trinomial, especially since truly intergrading forms are not yet known to occur.

Genus **SYMPLECTOTEUTHIS** Pfeffer, 1900.

Symplectoteuthis oualaniensis (Lesson, 1830) Pfeffer, 1900.

Loligo oualaniensis Lesson, 1830, p. 240, pl. 1, fig. 2.
Symplectoteuthis oualaniensis Pfeffer, 1900, p. 180.
Symplectoteuthis oualaniensis Wülker, 1910, p. 21 (merely noted).

Distribution.—Near Misaki, Sagami (Wülker). Laccadive Islands (Hoyle); Vanikoro (Quoy and Gaimard); Caroline Islands (Lesson); Torres Straits, Great Barrier Reef, and Nickol Bay, Australia (Brazier); Laysan Island (Schauinsland); Cocos Islands (Hoyle).

Family **THYSANOTEUTHIDÆ** Keferstein, 1866.

Genus **THYSANOTEUTHIS** Troschel, 1857.

Thysanoteuthis rhombus Troschel, 1857.

Thysanoteuthis rhombus Troschel, 1857, p. 70, pl. 4, fig. 12; pl. 5, figs. 1–4.
Thysanoteuthis rhombus Jatta, 1896, p. 56, pl. 9, figs. 1–13.
Thysanoteuthis rhombus Pfeffer, 1900, p. 182.

An Atlantic and Mediterranean species quoted from Japan without more definite locality on the authority of Pfeffer.

Family **CHIROTEUTHIDÆ** Gray, 1849.

Sub-family CHIROTEUTHINÆ Chun, 1908.

Genus **CHIROTEUTHIS** d'Orbigny, 1839.

Chiroteuthis macrosoma Goodrich, 1896.

Chiroteuthis macrosoma Goodrich, 1896, p. 12, pl. 3, figs. 51–57.
Chiroteuthis macrosoma Pfeffer, 1900, pp. 185, 186.
Cheiroteuthis macrosoma Nishikawa, 1906, pp. 109–113, pl.
Chiroteuthis macrosoma Chun, 1910, p. 240.

Distribution.—Japan (Nishikawa). Off the Kistna Delta (type locality, Goodrich).

Sub-genus CHIROTHAUMA Chun, 1910.

Chiroteuthis (Chirothauma) imperator Chun, 1908.

Chiroteuthis imperator Chun, 1908, p. 88.
Chiroteuthis (Chirothauma) imperator Chun, 1910, pp. 240, 241; texttafel 2; pl. 38; pl. 39, figs. 1–10; pl. 40, figs. 2–5, 7; pl. 41; pl. 42, figs. 1–4; pl. 43; pl. 44, figs. 3, 6–16.

Distribution.—Sagami Bay (Chun). Off Nias, Sumatra (type locality, Chun).

Family **CRANCHIIDÆ** Gray, 1849.

Genus **LIOCRANCHIA** Pfeffer, 1884.

Liocranchia sp.

A single very immature individual of an undetermined *Liocranchia* from Japan is in the author's collection [S. S. B. No. 385].

Order TETRABRANCHIATA Owen, 1832.

Sub-order NAUTILOIDEA.

Family NAUTILIDÆ Owen, 1836.

Genus NAUTILUS Linné, 1758.

Nautilus pompilius Linné, 1758.

Nautilus Pompilius Linné, 1758, p. 709, Nos. 283, 233.
Nautilus Pompilius Lischke, 1859, p. 29 (mere note).
Nautilus Pompilius Dunker, 1882, p. 1 (mere note).
Nautilus sp. Dean, 1901, p. 819.

Distribution.—Japan (Dunker); near Misaki, Sagami (Dean); Loo Choo Islands (Lischke). Indo-Malayan region.

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Fig. 6.—*Abraliopsis scintillans* ♀, left tentacle club of cotype, inner aspect, drawn from a mount in balsam; × 13; [147].

Fig. 7.—*Sepia formosana*, left tentacle club of type, inner aspect; × 2½; [361]. Drawn by John H. Paine.

Note.—Plates VII and VIII and figs. 3 and 4 of Plate VI are from photographs by Mr. John H. Paine, of Stanford University. The remaining illustrations with the exception of fig. 7 on Plate IX were drawn by Miss Lora Woodhead, of Stanford University.

A NEW SPECIES OF VERTIGO FROM FLORIDA.

BY E. G. VANATTA.

Vertigo hebardi n. sp.

Shell umbilicate; rather short; oval; very small, fragile, corneous; whorls 3½, convex, the first smooth, penultimate irregularly striate, body whorl with a few growth striæ. Aperture semi-ovate, provided with 5 teeth, parietal lamella very high and long, angular much lower and shorter than parietal, columellar very strong and directed downward, the two palatals are high and short. No crest behind the outer lip.

Alt. 1.25, diam. .84 mm.

This species is much smaller than *V. rugosula* St. and does not have such long palatals; it is smaller than *V. oralis* St. and has fewer teeth, also lacks the impression on the outer lip.

Type in the collection of the Academy of Natural Sciences of Philadelphia; Number 106,359; picked from leaf-mould collected on Long Key, Florida, by Mr. Morgan Hebard. It was associated with *Chondropoma dentatum* Say, *Helicina clappi* Pils., *H. tantilla* Pils., *Polygyra c. carpenteriana* Bld., *Thysanophora incrustata* Poey, *T. selenina* Gld., *T. cæca* Guppy, *T. plagioptycha* Shutt., *Vitrea dalliana* 'Simps.' Pils., *Varicella g. floridana* Pils., *Succinea floridana* Pils., and 19 specimens of *Drymæus multilineatus* Say, two of which are almost entirely black.

OBSERVATIONS ON THE STRUCTURE OF SOME CORAL BEDS IN THE HAMILTON SHALE.

BY BURNETT SMITH.

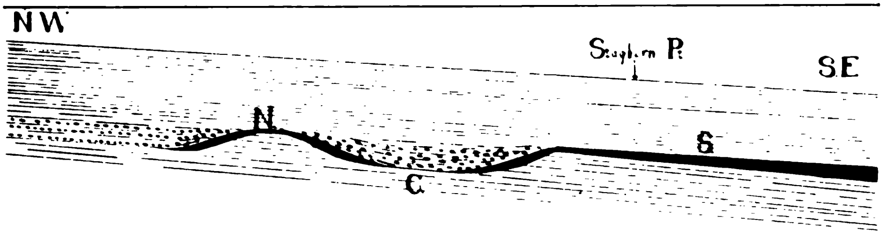
In the majority of the Paleozoic systems layers of rock occasionally occur which are made up in large part of the remains of corals. These coral masses in the attitudes and in the mutual crowding of their individuals, as well as in their general field relations, exhibit conclusive evidence that they lie in the position of original growth. From certainly the Silurian upward we find among such coral layers many which in structure approach, to a greater or less degree, the reefs of existing seas. Such fossil reefs are, as might be expected, more abundant in the limestones, and probably the Silurian and Devonian rocks of this type furnish us with the best examples which are to be found throughout the North American Paleozoic series.[1] In most cases, however, the reefs can be studied for only a small part of their extent. For instance, the Onondaga limestone of New York State is in many localities and through much of its thickness nothing more than an old reef, but here, as a rule, only a small horizontal section is exposed and the delimiting of the actual margins of the coral masses must be left to the field of conjecture. In the later Hamilton shale of the same region corals are a rather inconspicuous element when compared with the rich fauna of brachiopods and mollusks. Locally, however, we find in the shales layers which are composed of corals to the practical exclusion of other forms of life. Such layers are, in the main, of small thickness, and in studying them we are again confronted with the usual limited horizontal exposure. The coral reefs (if they can be dignified with the term) which form the basis for this description are an exception in this last respect, for they present a large and very beautiful exposure of about a mile along the eastern shore of Skaneateles Lake, in Onondaga County, New York.

For purposes of convenience in presentation it is advisable to consider these structures under the following headings: (1) The

[1] See T. C. Chamberlin, in *Geology of Wisconsin*, vol. I, 1873–79; C. J. Sarle, in *American Geologist*, November, 1901, pp. 282–299 (chiefly Bryozoa), and A. W. Grabau, in *Bull. Geol. Soc. Am.*, vol. 14, p. 337, 1903–4.

Large Southern Reef; (2) The Channel, and (3) The Small Northern Reef.

The Large Southern Reef.—As we follow the shore of the lake northwestward from Spafford Landing (Skaneateles Quadrangle, U. S. G. S.), the corals first appear above water level on the north side of a small point known locally under the terms Ivy Point and also Willow Point. The reef at its first appearance ranges from 3.5 feet to 4 feet thick and is made up almost entirely of the hard parts of *Zaphrentis*, *Heliophyllum*, and *Cystiphyllum*, together with the silt which filled the interstices between the growing corals and brought an end to their growth. The reef maintains this uniform character and thickness as far northwestward as the point known locally as Staghorn Point—a distance of approximately two-thirds of a mile. From Ivy Point the reef rises gradually for a ways, then runs with little or no dip well up toward Staghorn Point, where the



Diagrammatic northwest-southeast section of the Staghorn Point Coral Masses in the Hamilton Shale of Skaneateles Lake, N. Y.

Reefs in solid black. Shales in lines. Channel and reef-margin deposits in lines and dots. S = Southern Reef. C = Channel. N = Northern Reef.

dip increases. Its base is from 1 to 2 feet above high-water mark just south of Staghorn Point. Throughout this distance (from Ivy Point to Staghorn Point) the reef is apparently entirely conformable with the beds above and below. It is underlaid by thickly bedded hard limy shale, which carries a characteristic Hamilton fauna rich in brachiopods and mollusks. It is immediately overlaid by shales carrying a sparse fauna, the typical Hamilton assemblage reappearing a few feet above the reef. In the reef itself the species of brachiopods and mollusks, so abundant throughout the rest of the Hamilton, are almost entirely lacking.

Just north of Staghorn Point the base of the reef is about 5 feet above the lake level and its thickness has fallen to about 3 feet. For a distance of about 700 feet northward the reef rises until it is

finally about 8 feet above the level of the lake, while during this rise it thins rapidly down to about 9 inches in thickness. Throughout this thinning it still maintains the same conformable relations with the thickly bedded shales below and the thinly bedded shales above, as were observed south of Staghorn Point.

The reef now takes a sharp drop toward the north and thin layers of corals and limy shales fan away from it (Pl. X, Pl. XI, fig. 1). As we approach lake level the mass of corals thickens, but it is soon lost again in the complex of thin interbedded layers. We are here evidently on the northern border of the southern reef.

The Channel.—The space between the reef above described and that which lies to the north was evidently an open channel during most of the time when the corals of the two reefs flourished. The abrupt descent of the fanning layers from both reefs toward mid-channel and the discordance with the uniform southerly dip of the shales which later overwhelmed the reefs point conclusively to contemporaneous erosion for an explanation of the observed phenomena. This channel was gradually filled with limy silt, and occasionally an invasion of undersized corals ventured out into the currents only to be stifled by more silt without attaining maturity. These conditions are recorded by from 7 to 8 feet of thin limy shales and interbedded colonies of scattered corals. Ripple marks and cross-bedding in the limy layers bear witness to the shallowness as well as to the motion of the water in this old channel.

The Small Northern Reef.—At the southern edge of this small reef the conditions observed at the northern margin of the larger southern reef are duplicated. A thick mass of corals occurs near the lake level. These corals rise rapidly and during their rise from the lake the beds deposited in the old channel are seen to fan away from them. The reef rises sharply to a height of 10 feet above the lake, and here it is little more than a foot in thickness. Followed a short distance north, the conditions on the southern edge are again met with, the reef descends rapidly, thickens, and thin limy shales and coral colonies fan away from the main mass. Just north of the reef border this series of thin, ripple-marked, limy shales and seams of corals is about 9 or 10 feet thick. These beds, which owe their origin to the coral growths and to the disintegration of the corals, maintain their character for some distance along the lake shore—that is, for some distance away from the reef (Pl. XI, fig. 3), but, being reef-margin deposits, their distinctive features disappear as the distance from

the reef increases, and we can observe a gradual lateral transition into contemporaneous shale of the typical Hamilton facies.[2]

Sequence of Events.—In interpreting the observed facts we can assume with reasonable certainty that a local shallowing of the Hamilton Sea combined with an introduction of clearer water currents produced the conditions which were favorable to the growth of the corals. The limy shales were followed by communities of corals. During the growth of these beds currents kept a channel excavated in the northern portion of the region of coral growth. This channel was slowly filled with lime mud derived from the growing reefs and by invading colonies of corals, which latter, however, were never able to maintain their existence for long in the waters of the channel. Lime muds also derived from the reefs spread out for a small space around the northern margin of the area of coral growth.

When the channel between the two reefs was nearly filled with lime mud, the whole reef area was overwhelmed by fine land-derived clay muds. This effectually stopped the growth of the reefs, exterminating the corals and reintroducing the prevalent fauna of the Hamilton Seas.

CORRELATIONS.

As far as the author has been able to learn, the few references to the Staghorn Point coral masses which are to be found in geological literature are rather short and incidental. In view, however, of the advisability of correlating these reefs with one of the various Hamilton coral-bearing beds which occur in other portions of the county and of the State, the author believes it pertinent to mention here such references as are known to him.

In 1886 Mr. E. B. Knapp,[3] in a paper read before the Educational Council of Onondaga County and published at a later date, speaks of the principal collecting grounds for corals in the local Hamilton. We find also that he gives 6 feet as the thickness of the "old coral reef" at Staghorn Point.

Schneider,[4] in 1894, speaks very briefly of "the ancient coral reef at Staghorn Point" as an excellent collecting ground for cyathophylloid corals, but makes no mention of the size or structure of the reef.

[2] We have good negative evidence that the section above described is near the western limit of the coral masses, for considerable search has failed to disclose any reefs on the western shore of Skaneateles Lake.

[3] Knapp, E. B., *Glimpses of the Geology of Onondaga County*, p. 5.

[4] Schneider, P. F., *Notes on the Geology of Onondaga County*, Syracuse, 1894.

Luther,[5] in his *Economic Geology of Onondaga County, New York* (p. 282), says: "On the east shore, near Staghorn Point, is a very remarkable bed of fossil corals. It is a solid mass of cyathophylloid or cup corals, together with other genera. It is 5 feet thick at the thickest place, and is exposed along the shore, near the level of the water, for a distance of a quarter of a mile or more. Thousands of specimens, some of them 10 or 12 inches long, and sufficiently suggestive of staghorns to give the name to the point, are in sight in the layer or loose in the water. This coral reef, or a similar one at about the same horizon, is exposed at Lord's Hill, several miles northeast, and along the hillside west of Otisco Lake. From its position it seems probable that this bed is the eastern extension of the Encrinal band of the western counties, which abounds in cyathophylloid corals of the same species."

Cleland,[6] in his *Fauna of the Hamilton Formation of the Cayuga Lake Section in Central New York* (p. 85), after refering to Luther's observations, says: "Since in Ontario, Seneca, and Cayuga Counties the most abundant coral faunas are in the Basal Hamilton, either this coral reef at Skaneateles Lake is (1) a continuation of the stratum called the 'Basal Hamilton,' which is several hundred feet above the Marcellus shales in the Cayuga Lake section, or (2) the Encrinal, or (3) the union of (1) and (2), or (4) a separate stratum." Lower on the same page we find: "East of Cayuga Lake the correlation of the coral zones is yet to be worked out. However, conditions of sedimentation, such as would produce a limestone stratum anywhere in the Middle Hamilton, would be adapted to and contain what might be called a limestone fauna which would not differ materially from the fauna of the Encrinal; and whether this stratum were continuous or not, the same association of fossil would probably exist."

Leaving the interesting question of the possible equivalency of the Staghorn Point reefs with "the Encrinal" or some other of the western lime bands, let us return to the much nearer coral layers which are found to the east and northeast of Staghorn Point. Luther's locality of "Lord's Hill" I have so far been unable to identify with absolute certainty, but the exposures on the "hillside west of Otisco Lake" are numerous and probably most of them have been visited. These latter are known to exhibit an approximately northwest and southeast outcrop for about 3 miles, and as the

[5] Luther, D. D., *Rep. N. Y. State Geologist*, 1895.
[6] Cleland, H. F., *Bull. 206, U. S. G. S.*

lower limit of the corals ranges in altitude between 1,000 feet and 1,060 feet it is reasonable to assume that the exposures trend not far from the line of strike. The coral beds of the Otisco Valley present certain differences from the Staghorn Point masses. In the first place, the coralline strata are usually thicker, probably 10 feet thick at the northernmost exposure examined, while at a ravine cutting across the north and south road which leads to the Otisco causeway[7] we find two beds of corals—a lower one of undetermined thickness at 1,000 feet altitude separated by non-coralline shales from an upper bed which is at least 30 feet thick. The Otisco exposures are for the most part in very narrow gullies choked with débris, and though there can be no doubt that they represent an essentially continuous system, the exact structure is hardly determinable.

The question then naturally arises as to whether or no these Otisco Valley reefs are the contemporaries and the stratigraphic equivalents of the Staghorn Point reefs. Checks with a reliable reference plane are hard to make in the Otisco Valley, but the coral masses appear to lie about 300 feet below the base of the Tully limestone, while in the Skaneateles Valley the corresponding difference is about 360 feet. Considering the great variations in thickness which these coral masses exhibit, we are, it is believed, justified in regarding this evidence as pointing to essential stratigraphic equivalency.

Regarding, then, the Otisco Valley and the Staghorn Point masses as a practically contemporaneous system of coral bodies growing in the same sea, it is advisable to notice here two other Onondaga County exposures—those near the hamlets of Vesper and Joshua (Tully Quadrangle, U. S. G. S.).

The Vesper Reef is exposed in the Fellows Falls ravine and has been mentioned very briefly by Clarke[8] and Luther as "exposed in the Fellows Falls ravine 3 miles west of Tully." This bed is about 6 feet and 4 inches thick and lies approximately 350 feet below the Tully limestone or in practical agreement with the Staghorn Point reefs.

The coral layers near Joshua[9] lie at a much higher altitude than any of the others and their exact horizon is much less susceptible of precise determination. They are exposed between the 1,180 and

[7] The causeway is represented in an unfinished condition on the topographic map of the Skaneateles Quadrangle (U. S. G. S.).

[8] Clarke, John M., and Luther, D. D., *N. Y. State Museum Bull.* 82, p. 48.

[9] This is presumably Luther's "Lord's Hill" locality. See pl. 79, Lot 218, in *Sweet's New Atlas of Onondaga County*, New York, 1874.

Reef (text figure, S). Illustrates the abrupt northward (to the left) descent of the marginal deposits (*b*) into the channel (see text figure, C) and the truncation of the southward dipping shale (*a*) below.

Fig. 2.—Northern margin of the Southern Reef. In this figure the reef itself cannot be distinguished, but its base is shown by the top of the truncated shale below the reef. The discordance between the line of truncation (*x*, *y*) and the southward dip of the shale above the reef is also illustrated.

Fig. 3.—Reef-margin deposits about the northern border of the Northern Reef (see text figure, N). These deposits lie beyond the area in which fanning occurs and their alternating hard and soft layers are essentially parallel. The hard layers are limy and the soft layers are friable shale.

THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

NEW POLYCLADS FROM MONTEREY BAY, CALIFORNIA.

BY HAROLD HEATH AND ERNEST A. McGREGOR.

The material serving as a basis for the present paper was collected along the rocky beaches on the southern border of Monterey Bay or was dredged in the shallow water off shore. That it does not embrace all of the polyclads inhabiting this region is recognized, but it probably includes the more common species, and will, it is hoped, stimulate others to complete the list and extend their investigations into other localities bordering the western coast of North America. It is a surprising fact that up to the present time, so far as we can learn, but three species of these animals have been recorded between Panama and the coast of Asia, a distance of over 7,000 miles. Stimpson's characteristically brief diagnosis of *Leptoplana maculosa* is far from being exclusive, and accordingly must exist as a *nomen nudum*. On the other hand, Miss Plehn's description of *Leptoplana californica* and *Amblycereus luteus* is accurate and complete, as we know from specimens in hand.

Concerning the habits of these animals, we have unfortunately little to say on the subject. In captivity practically all of the species fail to thrive, and if they live at all withdraw into some shaded nook or remain quiet for hours together. In their native haunts they are even more retiring, and observations upon their mode of life are very difficult. *Planocera californica* occupies sites farthest removed from low-tide mark. Under stones or in crevices of the rocks it finds a hiding place and a food supply consisting of small animals together with scant quantities of diatoms. Throughout the greater part of the year its egg masses, forming more or less circular patches from two to six millimeters in diameter, appear like encrusting plant growths concealed in crevices of the rocks or attached to the under surfaces of boulders scattered on the beach. About mean-tide mark and even higher on the shore where the surf breaks strongly, and from such situations down to the low-tide mark, nearly all of the species of *Leptoplana* find a home. *Leptoplana rupicola* was encountered upon two occasions only attached to the under surface of large rocks at about the limit of extreme low tide. This is likewise the habitat of *Leptoplana timida* and *Stylostomum*

californicum. Nothing further is known concerning their mode of life. *Leptoplana inquieta* was dredged on one occasion in water about six fathoms in depth; it is usually concealed in the burrows of rock boring mollusks (*Penitella penita*), and when dislodged proves to be an active, restless species incapable of living in captivity. *Leptoplana saxicola* is peculiar in that it inhabits small, elevated tide pools whose waters are changed only during rough weather, when they are submerged in the dashing surf. A growth of algæ (*Cladophora*) frequently lines such pools, and in its feltwork this species may be found in abundance, living upon small mollusks, crustacea, and an occasional rhabdocele, whose remains have been found in the digestive tract. The species of *Eurylepta* and *Amblycereus* are usually found in the rhizoids of the brown kelp (*Macrocystis pyrifera*). *Amblycercus luteus* is an active swimmer, progressing by means of wave-like undulations of the margins of the body. Most of the remaining species described in the following pages were secured from collections made by students attending the seaside laboratory of Stanford University at Pacific Grove and were gathered at low tide, though we have no accurate information concerning their exact habitat or mode of life.

The food of several of the species consists largely of minute organisms in the plankton or small, strictly littoral species. In their digestive tracts have been found small spores, unicellular plants, especially diatoms, numerous sponge spicules, remains of amphipods and isopods, multitudes of *Sabella* larvæ, small annelids and the radulæ of gastropod mollusks. These substances frequently impart a characteristic color to the animal, and several of the more transparent species derive much of their apparent outward tint to materials in the digestive tract, as is shown by keeping such animals in captivity without food until that already eaten has digested, when their true color becomes apparent.

In the fixation of these animals the ordinary methods were employed. Lang's formula particularly was used with good results, but was slightly inferior to another solution that we devised during the course of our study. To 4 parts of a saturated solution of corrosive sublimate 1 part of formaldehyde was added, and 100 parts of this mixture were combined with 5 parts of glacial acetic acid. The solution was used hot and usually was poured over the specimen, though active, highly contractile individuals were often imprisoned between two microscope slides lightly held together. When this last-named device was employed, the specimen usually remained attached

to one of the slides, and in this position was passed through the various grades of alcohol and cleared and mounted. In a few species the active movements of the body may be inhibited to a considerable degree by allowing them to remain for some time in sea water held in small vessels, but in the greater number of cases the resulting sluggishness is accompanied by an abnormal distortion of the body that is difficult to overcome. Chloretone (aceto-chloroform) and a number of other narcotizing agents were used from time to time, but without much success, since the animals, even while comparatively active, would undergo a surprising degree of disassociation of the tissues. Delafield's hæmatoxylin was usually employed as a stain, occasionally with Orange G or rubin, and after such treatment the specimens were generally examined in clove oil and finally mounted in balsam.

KEY TO CALIFORNIA SPECIES.

I. Without sucking disc on ventral surface.... Tribe ACOTYLEA.
- A. Nuchal tentacles present ....Family PLANOCERIDÆ.
  - a. Pharynx almost wholly in middle half of body; antrum-masculinum continued close to dorsal surface as a crescent-shaped blind sac; accessory sac 3-parted, *Planocera californica*.
  - aa. Pharynx nearly central; antrum-masculinum normal; accessory sac normal.
    - b. Nuchal tentacles at beginning of second fourth of body; ample pharynx with large deep folds; sex openings rather close to posterior border of pharyngeal pocket.... *Planocera burchami*.
    - bb. Nuchal tentacles before end of first fifth of body; pharynx small and weakly folded; gut branches anastomosing; sex openings far removed from pharyngeal pocket and from posterior end of body, *Stylochoplana californica*.
- AA. Nuchal tentacles wanting ..... Family LEPTOPLANIDÆ.
  - a. A single seminal vesicle.... Genus LEPTOPLANA.
    - b. Separate sex openings.
      - c. Vasa deferentia anastomosing .... *L. rupicola*.
      - cc. Vasa deferentia unbranched; gut branches anastomosing.
        - d. Pharynx central, deeply lobed; penis broad, blunt; accessory sac lying wholly behind the female opening.... *L. timida*.
        - dd. Pharynx considerably nearer the posterior end, weakly folded; penis very long, attenuate; accessory sac lying wholly before the female opening .. *L. saxicola*.

bb. Common sex opening.
c. Tentacle eyes small, numerous; cerebral eyes minute, converging anteriorly........*L. californica*.
cc. Tentacle eyes large, few; cerebral eyes not converging........*L. inquieta*.
aa. A pair of seminal vesicles........*Phylloplana litoricola*.
II. With sucking disc on ventral surface........Tribe COTYLEA.
A. Numerous gut branches; tentacles appear as marginal folds; pharynx folded........Family PSEUDOCERIDÆ.
a. Approximately 50 pairs of gut branches, *Lichenoplana lepida*.
AA. Few gut branches; solid marginal tentacles; pharynx without folds........Family EURYLEPTIDÆ.
a. Mouth and male sex opening a common aperture; female pore before hind end of pharynx, *Stylostomum californicum*.
aa. Mouth and male aperture not united; female opening behind posterior end of pharynx.
b. Mouth immediately behind the brain which is close to the anterior body margin; male aperture under front end of pharyngeal pocket; tentacles lacking, *Aceros langi*.
bb. Mouth well removed from brain and body margin; male aperture behind pharyngeal pocket or ventral to posterior end of it; tentacles usually present.
c. Eyes lacking in region of tentacles; vasa deferentia and uteri anastomosed; no uterus glands, *Anciliplana graffi*.
cc. Eyes present in tentacle region.
d. A pair of uterus glands present; gut branches and vasa deferentia not anastomosing, *Eurylepta aurantiaca*.
dd. Uterus glands wanting; gut branches anastomosed........Genus EURYLEPTODES.
e. Granular gland present; vasa deferentia unbranched.
f. Tentacles well developed........*E. cavicola*.
ff. Tentacles absent or rudimentary,[1] *E. pannulus*.
ee. Granular gland absent; vasa deferentia elaborately anastomosed........*E. phyllulus*.

Tribus ACOTYLEA.

Without sucking disc. Mouth in middle of the body or behind it. Pharynx ruff-like. Copulatory apparatus in the posterior end of the body. Without tentacles or with nuchal tentacles.

[1] Cf. page 485.

Family PLANOCERIDÆ Lang, 1884.

With nuchal tentacles. Mouth about the middle of the body. Penis directed backward.

Genus PLANOCERA de Blainville, 1828.

With slender, pointed nuchal tentacles well removed from the anterior end of the body. Separated sex openings a considerable distance from the posterior end. Eyes on bases of tentacles and in the brain area.

Planocera californica sp. nov.

This species is fairly abundant along the southern coast of Monterey Bay, and to the south for at least thirty-four miles. It usually occurs above mean tide in crevices of the rocks and beneath boulders on the beach. The ground color is light transparent olive, upon which a system of chocolate-colored markings occur, corresponding closely to the position of the digestive tract. A long bar of this color extends along the mid-dorsal line from the front of the brain to the reproductive openings, sending off lateral branches along its course which ramify to the body margin. On the ventral surface of the animal the tissues are unpigmented and the somatic muscles are of whitish cast and so opaque that the internal organs are invisible.

The largest specimen (Pl. XVIII, fig. 39) measured 24 mm. in length by 14 mm. in width, and the oval or broadly elliptical body is of very firm consistency. Nipple-like retractile tentacles occur immediately before the end of the first fifth of the body. The eyes (text fig. 1) occur in the two usual groups—one, consisting of about ninety large ocelli in each of the tentacle clusters distributed in and about the tentacles in somewhat spindle-shaped areas diverging anteriorly, while the other, the cerebral set, comprises about sixty-five smaller eyes, commencing at the level of the posterior border of

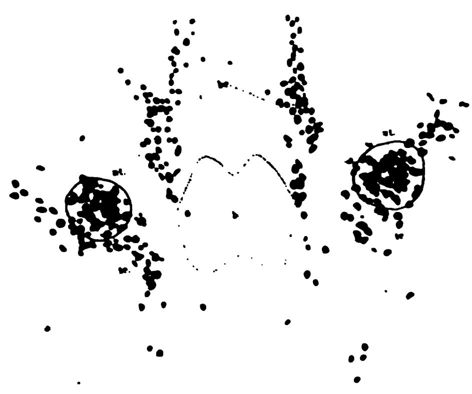


Fig. 1.—Eyes of *Planocera californica*.

the brain and extending directly forward along the sides of this organ to a point a little farther from the brain than its length.

The mouth (Pl. XVIII, fig. 39), situated somewhat in front of the middle of the body, opens into the pharnyx, which is placed almost entirely in front of the centre of the animal. Its length is between one-third and one-fourth that of the body, and is devoid of diverticula although it is moderately folded. The rather narrow main gut, of about the same length as the pharyngeal pocket, bears six or seven pairs of lateral branches with occasional alternating outpouchings. A median branch crosses the brain, and it like the others is without anastomoses.

It is evident that this species is carnivorous, as both the type and cotype contain radulæ of some gastropod mollusk. In one individual a radula occupies the anterior branch of the gut, extending across the brain, and shows signs of disintegration under the action of the digestive juice. Also in many of the gut pouches isolated teeth are to be seen in considerable numbers.

The brain is situated at the beginning of the second sixth of the body length, and is unusually clearly bilobed. The accompanying groups of granules (Körnerhaufen) are clearly evident, but the nerves, even in sections, are very indistinct, and accordingly no attempt has been made to determine their distribution.

The testes are ventrally distributed, but are not clearly united with the sperm capillaries, nor have these last-named canals been seen to unite with the vasa deferentia. Each vas deferens appears to originate at about the level of the male aperture, from which point each pursues its course directly forward as a convoluted, unbranched duct until abreast of the posterior end of the pharyngeal pocket where it bends suddenly inward and backward, finally opening beside its fellow into the small seminal vesicle (Pl. XV, fig. 24) located immediately posterior to the pharynx. The posterior contracted end of the seminal vesicle is continuous with the immense, spindle-shaped, granular gland whose walls are more or less continuous with the tissue of the penis. The slender penis is of an unusual type in that it is curved upward (Pl. XVI, fig. 32) and opens into a large cup-shaped cavity that is a dorsal continuation of the antrum masculinum. Several chitin-like spurs project into this space from its anterior wall. Ventrally the antrum is modified to form a long, slender passage, which opens to the exterior ventral to the above-described cavity.

The ovaries are in large measure dorsal, and in a few locations

have been seen to connect with what appears to be an anastomosing series of canals. The uteri are very distinct in the cotype, and are united anteriorly immediately in front of the pharynx. Relatively small ova occur throughout their entire length, save in the immediate neighborhood of the median egg canal. This last-named tube (Pl. XV, fig. 24) is continued posteriorly, and opens into the central region of the accessory sac, which in this species consists of three large pouches of equal size, the usual median one and an anterior pair bordering the egg canal. Anteriorly, the egg canal expands into the ample bursa, abundantly supplied with glands, that opens to the exterior not far behind the male aperture.

Planocera burchami sp. nov.

This species is represented by five individuals collected in Monterey Bay at a depth of ten fathoms. The color in alcohol was at first a brownish-pink over the pharyngeal area, with a dark brown line along the middle of the dorsal surface marking the position of the main gut. From the pharyngeal area outward, the color gradually changes to a creamy-pink in the neighborhood of the body margin. The entire dorsal surface is blotched with white pigment in varying quantity, though the spots are generally of small size. A small non-pigmented area between the tentacles marks the position of the brain. The ventral surface of the animal is unpigmented, and through the somatic musculature the brain, pharynx, uteri and vasa deferentia are clearly visible.

All of the specimens are broadly oval in outline, and the largest measured 14 by 11 mm. The mouth (Pl. XV, fig. 27) is placed very nearly in the centre of the ventral surface. The tentacles and brain are situated one-fourth of the body length from the anterior margin, the former appearing in preserved material as small, blunt, and hemispherical projections. Circular groups of eyes (Pl. XIII, fig. 9) are ranged about their bases, and numerous ocelli are also scattered irregularly between the tentacles. No eyes occur on the body margin.

The external mouth leads into the pharyngeal pocket that with broad, ample lateral divisions extends at least two-fifths of the body length. The main intestine, closely coinciding with the pharynx in outline, gives rise to six or seven pairs of stout lateral branches and an anterior offshoot, which immediately forms three subdivisions posterior to the brain. The ultimate divisions of the intestine have never been seen to anastomose.

The brain, about one-fourth the length of the body from the anterior end of the animal, is oblong in transverse diameter, slightly emarginate in front and behind, and gives rise to at least four pairs of lateral nerve trunks. Over most of the body the larger nerve trunks have been traced with unusual distinctness, and the results show that the nervous system in general conforms to the usual type.

The testes are ventral, and especially in an immature state their arrangement suggests that they are united by sperm canals, forming an anastomosing system, though, generally speaking, these capillaries are invisible. The vasa deferentia, on each side of the body, form a narrow, inverted-U-shaped loop whose distal end arises abreast of the male aperture, the bend occurring opposite the mouth. Owing to the rather poor preservation of the specimens, the details of the male reproductive apparatus could not be determined completely. The proximal ends of the vasa deferentia appear to terminate in what seems to be a large antrum masculinum (Pl. XVIII, fig. 44), but no seminal vesicle could be seen nor could the penis be clearly studied, although it is doubtless directed backward. The male sex opening is well removed from the pharyngeal pocket.

The ovaries are dorsal, and an anastomosing connecting system of oviducts exists. The uteri extend forward, running parallel to the inner limbs of the vasa deferentia, and thus pursue a course directly forward to the tentacles to terminate immediately behind them. Posteriorly, these canals pass dorsal to the vasa deferentia, and lateral to the male aperture where they bend quickly inward toward the median line. As in the case of the male reproductive system, the details of the female reproductive complex could not be ascertained with certainty. The uteri appear to lead directly into a large antrum femininum, but there are also indications of an accessory gland, though its relations were not established satisfactorily. The female sex opening is immediately behind that of the male system.

Two peculiar deep pits (Pl. XVIII, fig. 44, *dp*), one immediately in front of the level of the male aperture and one immediately behind the female aperture, occur on the dorsal surface connected by a narrow, shallow groove. This appears in two of the largest individuals, but there is no clue to their function.

Named in memory of Mr. Samuel Burcham, who undertook the investigation of the polyclads of the California coast while a student at Stanford University. This work, still in its early stages, was terminated by his untimely death.

Genus **STYLOCHOPLANA** Stimpson, 1857.

Stubby tentacles about one-fifth the body length from the anterior end. Male and female genital pore united and well removed from posterior end of body. Eyes on basis of tentacles and in brain area.

Stylochoplana gracilis sp. nov.

This very small species is represented by eight individuals, all of which were taken on the broad thalli of *Macrocystis pyrifera*, growing in the vicinity of the wharf of the Del Monte Hotel, near Monterey. It was most often found on surfaces encrusted with colonies of bryozoa. The color of the dorsal surface is pale brownish-yellow or buff, fading gradually as the margins of the body are approached. The ventral surface is unpigmented, yet the tissues are so opaque that little more than the digestive tract is visible in living material.

The largest specimen measured 7.5 mm. in length by 3 mm. in width. In every case the outline of the body is cuneate-oval (Pl. XII, fig. 2) with a broad semi-truncate anterior margin, while the posterior end is usually pointed. The mouth is located slightly in front of the middle of the body. The penis is directed backward. Finger-like nuchal tentacles are placed at the end of the first body fifth. The eyes (Pl. XIV, fig. 20) are arranged in two groups. The tentacle pair, each consisting of about four medium-sized eyes, is confined to the basal portion of the tentacles, while the cerebral clusters, fairly well differentiated, comprise approximately fourteen eyes each.

The mouth (Pl. XII, fig. 2) opens into the pharynx, which is considerably nearer the anterior than the posterior end, and covers an extent equal to one-fourth the length of the animal. The pharynx is slightly folded only, though the resulting inconspicuous lobes are relatively numerous. The main gut is narrow, of moderate length, and possesses usually seven pairs of intestinal branches with alternating diverticula. The posterior pair terminate the gut immediately behind the pharyngeal pocket, but anteriorly a median branch continues forward across the brain. All of the branches immediately anastomose and continue to do so until close to the margin of the body.

The brain holds a position at the commencement of the second body sixth, but as the main nerve trunks to which it gives rise are typical and their ramifications are very difficult to follow, no serious attempt has been made to examine critically this particular system.

The testes, for the most part ventrally placed, have not been seen to connect with sperm capillaries, but the vasa deferentia, on the

other hand, are clearly defined, convoluted, unbranched canals continuous across the mid line immediately behind the female reproductive pore. From this point they swing forward, diverging gradually until opposite the posterior end of the pharynx where they bend abruptly, and parallelling the outer trunks for a relatively long distance pass inward and forward to the anterior end of the seminal vesicle. This last-named organ (Pl. XII, fig. 6) is of moderate size, muscular, oval in form, and is placed far behind the pharynx. Leaving it posteriorly the short ejaculatory duct immediately enters (Pl. XV, fig. 26) what is doubtless the granular gland. The latter is of an unusual type. It is round-oval in form and its walls, produced posteriorly, appear to be continuous with the tissue of the penis. The penis is short, blunt, and projects into an ample antrum masculinum.

Generally speaking, the ovaries are dorsal, but no connections have been traced between them and the uteri. These canals have their origin opposite a point midway between the mouth and the front end of the pharynx. From here they extend backward, closely skirting the pharynx, at whose posterior extremity they approach one another and close to the mid line continue their course, diverging slightly in order to pass around the male reproductive pore where they enter the common egg canal (Pl. XII, fig. 6). The latter is short, and almost at once extends forward and ventrally to open into the antrum femininum. Posteriorly, the egg canal is continuous with the moderate-sized accessory sac (Pl. XV, fig. 26). The female orifice is usually a short distance posterior to that of the male, though two specimens possess a common opening.

No histological examination was made of the reproductive system.

Leptoplana rupicola sp. nov.

This large species is represented by three individuals found adhering to the under surface of large rocks near extreme low-tide mark a short distance south of the entrance to Monterey Bay. The largest specimen, 35 mm. in length by 15 mm. in width, is somewhat oval in form (Pl. XII, fig. 3), having the anterior end more rounded than the posterior. The color above is light with a pinkish or reddish tinge very marked in one of the specimens. There is a dark brown or brownish-red line along the mid line in the region of the pharynx. At the margins of the body the color is usually very faint. Ventrally, pigment is absent and the reproductive system and the pharynx appear with considerable distinctness. A clear,

translucent spot marks the position of the brain. The mouth is situated almost exactly in the centre of the body. Tentacles are lacking. The penis is placed about one-third of the distance from the mouth to the posterior end, well behind the pharyngeal pocket, and is directed backward. The eyes (text fig. 2) are arranged in four groups, a comparatively long pair of approximately 30 eyes in each adjacent to the brain, and a small more rounded, laterally placed pair comprising about 30 eyes in each cluster. No eyes occur elsewhere in the body.

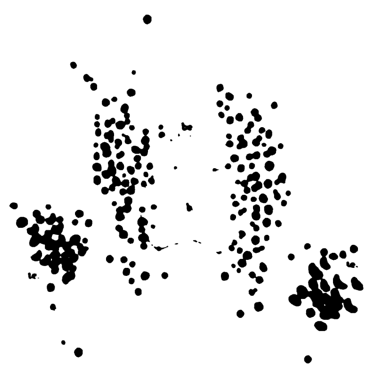


Fig. 2.—Eyes of *Leptoplana rupicola*.

The pharyngeal pocket, scarcely one-third the length of the body, is supplied with numerous irregularly lobed diverticula, corresponding in a general way to the folds of the pharynx. The main gut is of about the same length as the pharynx, though is much more slender in outline, and is provided with approximately fifteen pairs of lateral intestinal branches whose subdivisions give no signs of anastomosing.

The brain is placed very nearly one-fourth of the body length from the anterior margin of the body, and as described previously is associated with two pairs of eye clusters. The ventral system of nerves is fairly well defined and conforms to the usual type.

The testes are ventral, and what appears in sections to be an anastomosing system of sperm canals unites them with the vasa deferentia. The last-named tubes (Pl. XII, fig. 3) are continuous across the mid line immediately posterior to the female reproductive pore, and from this point extend forward, diverging somewhat, as they become increasingly anastomosed. Opposite a point slightly anterior to the level of the mouth this elaborate network bends upon itself, skirts the margin of the pharynx, and not far behind the posterior end of the gut each becomes reduced to a single duct which sweeps inward and forward to fuse with its fellow in the mid line. This median duct (Pl. XV, fig. 22) proceeds in an anterior direction for a short distance, then bends upon itself and immediately enters the small but muscular seminal vesicle. Emerging from this at the

opposite end, the canal plunges at once into the comparatively large granular gland (Pl. XIII, fig. 13), and after its exit pursues its course to the base of the penis. A triangular muscular sheath surrounds the seminal vesicle and the terminations of the vasa deferentia. The copulatory apparatus is single and of the normal type. A large antrum masculinum is present.

As usual, the ovaries are dorsal and the uteri anteriorly are continuous across the mid line (Pl. XII, fig. 3). Immediately posterior to the male reproductive opening the uteri bend inward and meet to form the median oviduct (Pl. XV, fig. 22) that exists in the form of a relatively large canal, on one hand uniting with the long yet ample accessory gland and in the other direction with the spacious shell gland chamber and the antrum femininum. The opening to the exterior is close to that of the male and immediately in front of the accessory gland.

Leptoplana timida sp. nov.

This species is evidently rare as it is represented by only two individuals taken along the southern shore of Monterey Bay. The color of the dorsal surface is clear, translucent white, dotted more or less uniformly with minute dark red spots. In the central regions of the body these pigment spots are closely grouped to form a transverse, saddle-shaped blotch that becomes especially conspicuous when the animal is in a contracted condition. On the ventral surface of the body pigment is lacking, and through the white, semi-transparent somatic muscles the pharynx and vasa deferentia may be distinctly seen in living specimens.

The body is broadly oval in shape (Pl. XII, fig. 1), blunt anteriorly, and the type specimen measures 23 mm. in length by 12 mm. in breadth. The mouth is situated a very short distance posterior to the centre of the body. Tentacles are lacking. The penis is located immediately behind the pharyngeal pocket one-fourth of the length of the body from the posterior end and is directed backward. The eyes (text fig. 3) are arranged as usual in four clusters, the cerebral consisting of about 40 in each on both sides of the brain, while the tentacle groups, each comprising 12 comparatively large irregular ocelli, are more laterally placed. No eyes occur on the margins of the body.

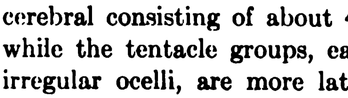


Fig. 3.—Eyes and brain of *Leptoplana timida*.

The pharyngeal sheath (Pl. XII, fig. 1) is of nearly half the body length and is provided with broad, irregularly lobed branches. Owing to the compression of the animal during its fixation, the main intestine cannot be clearly differentiated from the pharynx, but it apparently exists as an elongated organ extending the full length of the pharynx posteriorly and at least as far as the brain anteriorly. Approximately sixteen pairs of lateral branches have been distinguished which appear to finally anastomose, though of this we cannot be positive.

The brain is situated one-third of the distance from the mouth to the anterior end of the body, but neither it nor the nerves originating from it present any noteworthy features.

The testes are placed in the ventral half of the body, and although no anastomosing system of sperm canals could be distinguished, the position of the male reproductive glands suggests that one probably exists. The vasa deferentia (Pl. XII, fig. 1) present the form of a heart-shaped loop, since they are continuous across the mid line immediately behind the female aperture, from whence they extend anteriorly and laterally to arch inward ventral to the uteri opposite a point not far behind the mouth. They then bend backward and inward and, fusing, unite with the seminal vesicle (Pl. XIII, fig. 12), surrounded by an ellipsoid muscle sheath, situated immediately behind the posterior end of the pharynx. Emerging from this organ, the canal immediately pierces the spherical granular gland and enters the base of the penis. This last-named organ is unusually thick at its base in proportion to its length, and in the type specimen the opening to the exterior is opposite to its base.

The ovaries are dorsal and are connected with the uterus by an anastomosing system of capillaries. The uteri entirely surround the pharynx since they are continuous across the mid line anteriorly. Posterior to the penis, these canals swing inward and unite to form the single, median egg canal (Pl. XIII, fig. 12) that on one hand expands to form the spacious antrum femininum and in the other direction communicates with the accessory gland, a long, roomy sac extending well behind the female reproductive pore.

Leptoplana saxicola sp. nov.

This small flatworm is represented by numerous individuals taken at a point a few miles south of the entrance to Monterey Bay. It occurs usually in masses of algæ (*Cladophora*) in tide pools of such elevation that the water is renewed only during rough weather. Dorsally the ground color varies from yellowish to grayish-brown.

A light stripe generally occupies the area immediately above th main gut which may be bordered laterally by a brownish band When this last-named variation occurs, light streaks free from pig ment radiate from it to the margins of the body. A clear spo generally marks the position of the brain. On the ventral surfac pigment is entirely lacking or is present in very slight amounts, s that the more important organs may be seen through the translucen body wall with considerable distinctness.

The largest specimen measured 11 mm. in length by 5 mm. i width, and is narrowly elliptical in outline (Pl. XII, fig. 4). Th mouth is situated about one-third of the length of the body from th posterior end of the animal. The penis is directed backward. Bot cerebral and tentacle eyes (Pl. XIV, fig. 19) occur associated wit the brain; none exist on the margins of the body. The tentacl clusters form small groups lateral to the brain, each consisting c about ten medium-sized eyes. The cerebral groups are not sharpl differentiated from the others, but in a general way they present linear arrangement on either side of the mid line bordering th brain and anteriorly expand to form loose clusters in front of th brain. There are approximately 25 small eyes in each of thes groups.

The most conspicuous feature of the digestive system is th posterior position of the pharynx (Pl. XII, fig. 4) and external moutl The first-named organ is about two-fifths the length of the body an is provided with five or six folds of moderate size on each side. Th inner mouth is some distance anterior to the true mouth. Th main gut is long, rather narrow, and possesses six or seven pairs c lateral intestinal branches, with occasional alternating short diverticula, and an anterior and posterior outgrowth along the mi line. Anastomosing immediately commences, resulting in a highl complicated intestinal network. Varying quantities of diatom and sponge spicules were generally present in the digestive tract.

In this species the nervous system appears with unusual distinc ness and has accordingly received more than usual study. Th ventral system (Pl. XIV, fig. 21) conforms closely to the type foun to occur in polyclads generally, but in addition to this there is wh appears to be an independent network extending over the enti dorsal surface of the body. It comprises three pairs of main branche arising from the lateral and anterior surfaces of the brain, that aft dividing repeatedly extend to the margins of the body. Along th mid line, in the region of the pharynx, these delicate fibres becom

lost to sight owing to the opacity of the animal, but as they appear here and there in sections it is probable that the network spreads over the entire dorsal surface of the body. The average size of the component nerve bundles is less than those of the ventral side, and the meshwork is considerably more open; otherwise there are no especially noteworthy features not represented in the figures.

Heath ('07) has described a dorsal nervous system, conforming to the same general plan, in *Planocera hawaiiensis*, and it is known to exist in the trematodes (cf. Heath '02). Lang has theoretically related the ctenophores and the flatworms on the basis of several deep-seated resemblances, appearing especially in the course of the embryological development. In the ctenophores there is, as is well known, a nervous system fashioned on the quadriradial plan. In the chiton larva there are likewise indications that in the early stages the central nervous system is constructed upon essentially the same plan. In the chiton the dorsal limbs of the cross-shaped fundament disappear apparently without becoming functional, but it is possible, though by no means proven conclusively, that they persist in the polyclads and develop into the network of the dorsal side of the body.

The testes, ventral as usual, are united by delicate sperm capillaries with the convoluted but unbranched vasa deferentia (Pl. XII, fig. 4), which present the form of an inverted-U-shaped loop. The outer limb of each loop passes backward to fuse with its mate immediately behind the female reproductive pore. The inner trunk extends inward and backward and unites with its fellow in the mid line to form a short common duct (Pl. XVI, fig. 30), which at once enters the posterior end of the large, elliptical seminal vesicle situated close behind the pharynx. Leaving the seminal vesicle anteriorly, the sperm canal, functioning as a ductus ejaculatorius, turns directly backward and, piercing longitudinally the very large, oval granular gland, immediately enters the base of the penis. This last-named organ in this species is unusually long and attenuate, and is contained in a similarly slender sheathing chamber at whose apex the external pore is located.

The ovaries are dorsal and are united by tubes, very indistinct except during the egg-laying season, that in turn connect with the uteri. These last-mentioned canals meet across the mid line anteriorly (Pl. XII, fig. 4) not far from the posterior border of the brain and, arc-like, extend backward with occasional anastomoses in some individuals, if not in all. In some cases well-developed outpouchings of the uteri occur, especially in the region of the brain and at a point

about opposite the mouth. Proximally, the uteri converge immediately behind the male reproductive opening and enter the short, stout egg canal (Pl. XVI, fig. 30) that in turn communicates with a short yet spacious accessory sac situated in several instances anterior to the external opening. Posteriorly, the egg canal expands into the antrum femininum which communicates exteriorly by means of a pore very close to that of the male reproductive system. In a few individuals, young and old, there is a common reproductive opening.

Although this is a small species, the ova are the largest that have been observed by us. In one case measurements showed the diameter of an ovum to be one-seventh the width of the body, or more accurately stated, its diameter was 0.61 mm. About opposite the seminal vesicle, and within the loops of the vasa deferentia, there are to be seen a pair of small gland-like bodies (Pl. XVI, figs. 30, 85) whose connections have not been traced.

Leptoplana californica Plehn.

Broad oval. Length 12 mm., breadth 9 mm., broader in front than behind. Colorless in alcohol. Pharyngeal pocket central, in length equal to one-half that of the animal, with seven pairs of average-sized lateral diverticula, containing the sharply folded pharynx. Tentacle eye clusters small, elliptical, diverging anteriorly; cerebral groups longer and narrower, converging anteriorly, with a single large eye terminating each in front. Common sex opening near posterior end of body, leading on one hand into an ample bursa copulatrix and posteriorly into a large accessory chamber; uteri, surrounding the pharynx, lead to a well-developed antrum femininum; penis with a long, sharp and flexible stylet; a granular gland and seminal vesicle on direct line to union of vasa deferentia.

Type locality, Monterey Bay, Calif., at a depth of 30–40 meters. Two specimens in our collection agree with the foregoing description.

Leptoplana inquieta sp. nov.

Four species represent this species captured about the low-tide limit among the rocks, and in one case among the rhizoids of *Macrocystis* in Monterey Bay. It is a small, restless species, crawling rapidly when disturbed, but never swimming. Dorsally the color is clear, translucent white, dotted more or less uniformly with small dark red pigment spots. Ventrally it is unpigmented, and the pharynx and vasa deferentia show faintly through the body wall.

The largest specimen is broadly oval in form (Pl. XIII, fig. 8)

with the anterior end broadly rounded or even truncate, while the posterior extremity is narrowed. It measures 9 mm. in length by 5 mm. in width. The mouth is placed slightly behind the centre of the body. The penis is directed backward. Nuchal and marginal tentacles are wanting. Eyes occur in four distinct clusters (Pl. XVIII, fig. 43), the tentacle pair, each consisting of seven or eight large ocelli, and a pair of cerebral groups. The last-named comprise approximately thirty relatively small eyes in each set, forming an elongated patch bordering the brain. No eyes occur on the margins of the body.

The digestive system (Pl. XIII, fig. 8) presents no especially novel features. The external mouth leads into a considerably folded pharynx whose length is between one-third and one-half that of the body. Laterally it is produced into seven pairs of lateral diverticula. Directly dorsal to the outer mouth the opening from the pharynx leads into the mid-gut, which in turn possesses seven pairs of lateral intestinal branches together with an anterior offshoot leading forward across the brain. This system ramifies chiefly by means of simple branching, but occasional anastomoses were seen, especially in the neighborhood of the pharynx.

The brain occupies a position about one-fifth the length of the animal from the anterior end of the body. Neither it nor the main nerves are distinct, and accordingly have not been studied to any considerable extent, though sufficiently to decide that all conform to the customary type.

The testes are rather uniformly distributed, and the sperm canals leading from them appear to form an anastomosing system. The vasa deferentia are likewise delicate and somewhat difficult to follow, though their general features appear with considerable distinctness. From the seminal vesicle (Pl. XIII, fig. 8) each swings outward and forward, becoming somewhat anastomosed, and when they have reached points lateral to the uteri and midway between the mouth and the posterior end of the pharynx they turn sharply backward, pass inward toward the mid line and fuse immediately behind the pharynx. The remaining features of the male reproductive system (Pl. XIII, fig. 14) are relatively simple. From the seminal vesicle, which is adjacent to the posterior end of the pharynx, the ejaculatory duct pursues a short and direct course posteriorly to the penis. This last-named organ is enclosed within a spherical, muscular sheath from which a comparatively long, loop-shaped tube leads to the common reproductive pore.

The ovaries are dorsally placed, and their ducts, usually invisible, lead to the uteri which surround the pharynx, since they are anteriorly continuous across the mid line. Skirting the pharyngeal folds, the uteri extend backward (Pl. XIII, fig. 8) and fuse in the mid line, immediately posterior to the penis, to form the egg canal. This median canal is continuous posteriorly with the ample accessory sac (Pl. XIII. fig. 14), and in the opposite direction it enlarges into the thick-walled bursa copulatrix which in turn leads to the common opening.

It is interesting to note in this connection the presence of large quantities of spermatozoa, in two individuals, stored in the accessory gland. That it is not an accidental condition is evidenced by the fact that in many places sperms were attached in dense masses to the epithelial lining. This is the only species in which we have found male reproductive elements in the accessory gland, and accordingly we are not prepared to make any sweeping generalizations, but appearances lead us to the belief that in this species the accessory gland functions, at least in part, as a seminal receptacle.

Leptoplana maculosa Stimpson.

Oblong-ovate; above pale gray with a few yellow spots, median spots obscure, margin hyaline. Primary eye clusters in two ovate spots, seven in each; groups placed at the extremities of the hyaline, transverse, arcuate areola. Two small groups of secondary eyes situated before the middle of the areola; secondary eyes four to six, dispersed in the areola between the primary eyes. Length 0.8, breadth 0.4 inch.

In the Bay of San Francisco, along the shore under stones in marshy places. (Free translation.)

Although we have sought for this flatworm in the type locality and in Monterey Bay, we have discovered no specimens that can with certainty be identified as this species.

Genus **PHYLLOPLANA** Laidlaw, 1903.

Leptoplanoid with flattened, leaf-like body. A pair of long muscular vesiculæ seminales, which lie parallel to the median ductus ejaculatorius and penis and receive the vasa deferentia of either side, respectively, at their hinder ends.

Phylloplana litoricola sp. nov.

This species is represented by nine individuals, living on the under surface of stones below the medium-tide mark along the southern shore of Monterey Bay. It is fairly active and capable of swimming

actively for short distances. Dorsally the color is dark, marbled brownish-gray varying to almost black. A pale yellow streak extends along the median line in the region of the pharynx. This is bordered on each side by a dark, brownish line of similar length, which fades into the ground color. On the ventral surface of the animal pigment is lacking, the tissues appearing clear white and of such thickness that the internal organs are invisible in living material.

The largest specimen is long oval (Pl. XII, fig. 7) in outline and measures 19 mm. in length by 9 mm. in width. The penis is directed backward. Four distinct eye clusters (Pl. XVIII, fig. 42) occur associated with the brain, an elongated pair composed of small eyes on each side of the brain, and a more or less circular pair comprising larger ocelli located slightly behind the level of the brain.

The mouth, approximately central, opens into the much-folded pharynx (Pl. XII, fig. 7) that is nearly half as long as the body. A short distance anterior to the external mouth the inner mouth leads into the spacious and much elongated main gut provided usually with fourteen pairs of variously shaped intestinal branches. These last-named subdivisions branch dichotomously and give no evidence of forming an anastomosing system.

The brain is located about one-sixth of the body length from the anterior end of the animal, but as neither it nor the branches arising from it are distinct, no attempt has been made to study this system in detail.

As usual the testes are ventral and are thickly distributed, especially near the middle of the body. The vasa deferentia form a U-shaped loop (Pl. XII, fig. 7), the bow of which passes immediately behind the female reproductive pore, while anteriorly the two limbs turn sharply inward, and coursing parallel to the outer arms for half their length again bend quickly, and after pursuing an anterior course for a short distance expand to form two seminal vesicles (Pl. XV, fig. 23). These converge into a common duct, the ductus ejaculatorius, that after piercing the granular gland passes into the base of the penis. This latter organ is of the usual type, directed backward and opens to the exterior at a point about one-fifth the body

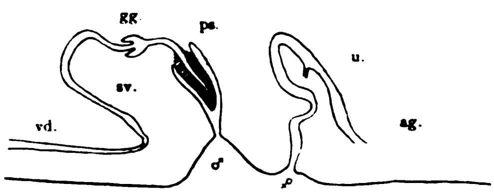


Fig. 4.—Longitudinal section through central reproductive apparatus of *Phylloplana litoricola*.

length from the posterior end of the body. There is a fair-sized antrum masculinum.

The ovaries are dorsal and communicate with the uteri by an anastomosing system of connecting tubules. The uteri, fused in the mid line anteriorly (Pl. XII, fig. 7), pass backward, skirting the margin of the pharynx, and then coursing parallel to the vasa deferentia posteriorly meet in the mid line. Here they enter the duct leading forward from the accessory gland (Pl. XV, fig. 23), and on the other hand pursue a somewhat tortuous course to expand into the antrum femininum, that opens to the exterior immediately in front of the posterior loop of the vasa deferentia. About opposite the granular gland of the male system the uteri become distended to form spindle-shaped glands, which may correspond to uterus glands in other species.

Two specimens were kept in captivity for a few days early in June, and deposited several hundred eggs at the average rate of one every forty-five seconds.

Tribus COTYLEA.

With sucking disc. Mouth in middle of the body or anterior to it. Copulatory apparatus in the anterior end of the body. Without tentacles or with marginal tentacles.

Family PSEUDOCERIDÆ Lang, 1884.

Body oval or elliptical with fold-like marginal tentacles. Mouth in middle of anterior half of body. Pharynx collar-like. Main gut long and spacious. Intestinal branches numerous and anastomosing. Eyes in brain area and tentacles.

LICHENIPLANA gen. nov.

Small papillæ on dorsal surface. Gut branches very numerous. Copulatory apparatus single.

Licheniplana lepida sp. nov.

This species is represented by four individuals collected on the under surface of stones on the southern shore of Monterey Bay. The largest specimen is broad oval in outline (Pl. XIV, fig. 17) and measures 12 mm. in length by 8 mm. in width. It is a very delicate species, living in crevices of the rocks or similar places of concealment, and when disturbed is exceptionally slow in its movements. Dorsally the ground color is white, gray, or lead color with occasional small pinkish or dark red pigment spots. The ventral surface is unpigmented.

The mouth (Pl. XV, fig. 17) is situated between one-fourth and one-fifth of the length of the body from the anterior end. The ventral sucker is placed approximately three-sevenths of the body length from the posterior end. The penis is between one-third and one-fourth of the length of the animal from the anterior margin, immediately behind the pharynx, and is directed forward. Nuchal tentacles are lacking, while the marginal tentacles appear as somewhat thickened flaps. Eyes, indefinitely grouped into two clusters (text fig. 5), occur between the tentacles, while a second pair of about fifteen eyes each and more clearly differentiated occupy the brain area. It is interesting to note that dorsal papillæ (Pl. XIII, fig. 11), of small size but clearly defined, exist in this species, being especially abundant in the anterior part of the body.

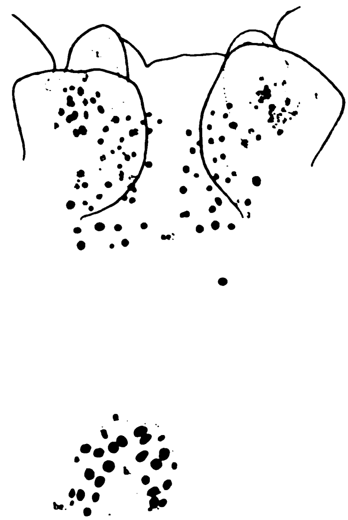


Fig. 5.—Brain and tentacle eyes of *Tichenipana lepida.*

The mouth (Pl. XV, fig. 17) opens into the much-folded pharynx which is between one-sixth and one-seventh as long as the body. Somewhat behind the external mouth the inner mouth leads to the main chamber of the gut, a long and spacious structure provided with approximately fifty pairs of lateral branches. These last-named subdivisions branch frequently and form a highly anastomosing system.

The brain is situated half-way between the anterior end of the body and the mouth, but the nerves to which it gives rise are very indistinct and little attempt has been made for this reason to work out the system in detail.

The testes are ventral and rather uniformly distributed. There is some evidence that these organs are connected by an anastomosing system of sperm capillaries, which eventually fuse to form the vasa deferentia (Pl. XV, fig. 17), relatively large, convoluted canals extending along the margins of the gut throughout most of its length. They arch inward to enter the seminal vesicle (Pl. XVII, fig. 36), almost spherical in form, without the formation of a common

canal. The ductus leaves the anterior end of the seminal vesicle, bends backward, then sharply downward and forward again to enter the base of the short, conical penis. Near the base of the penis this canal is joined by a very short duct leading from the granular gland, a small oval body that to a certain extent occupies a space between the penis and the seminal vesicle.

The ovaries are dorsal and connect with the uteri by means of ducts that very plainly anastomose. The uteri (Pl. XV, fig. 17) have been traced backward to a point about opposite the end of the main gut and forward to a point opposite the mouth. At the level of the female reproductive pore the uteri converge (Pl. XVII, fig. 36) and unite with a short median canal, the vagina, which leads anteriorly to the exterior at a point immediately posterior to the seminal vesicle.

Family EURYLEPTIDÆ Lang, 1884.

Body oval or elliptical, with or without solid marginal tentacles. Mouth near anterior end of body. Pharynx tubular. Main gut, long and narrow. Male apparatus simple. Eyes in brain region and tentacles.

Genus STYLOSTOMUM Lang, 1884.

Body smooth. Mouth and male sex pore communicating with a common atrium. Pharynx cylindrical. Gut pouches not anastomosing. Anterior median gut branch lacking in region of pharyngeal pouch. Female sex apparatus ventral to base of pharyngeal pouch. Tentacles very rudimentary.

Stylostomum lentum sp. nov.

This species is represented by six individuals taken near Monterey, Calif., at low-tide level. It is a sluggish animal and seemingly incapable of swimming. The ground color of the dorsal surface is orange. A somewhat darker shade occurs along the mid line from the eyes to the posterior end of the mid gut, but laterally this patch becomes lighter and near the margin of the body sends out ray-like expansions that alternate with irregular streaks of bright yellow. Minute white specks are scattered over the entire dorsal surface.

The largest specimen measured 9 mm. in length by 5 mm. in width, and was elliptical in outline (Pl. XIII, fig. 16). The mouth is situated immediately behind the brain about one-tenth of the length of the body from the anterior end and, as in other species of the genus, serves also as the male reproductive opening. The penis is directed forward. Short, blunt, and somewhat rudimentary tentacles (Pl.

XVIII, fig. 40) occur on the anterior margin with a cluster of approximately eighty small eyes at the base of each. The cerebral eyes form two rather long, closely approximated groups, with about fifty medium-sized ocelli in each, located chiefly posterior to the brain.

In the midst of the cerebral groups of eyes the mouth (Pl. XIII, fig. 16) occurs and leads into a long, spacious canal which may be considered as a portion of the pharyngeal cavity. The unfolded pharynx is tubular in form, but anteriorly it tapers to a fairly acute point. In length it equals about one-seventh that of the animal. Posteriorly it opens into a main gut of average size that usually gives rise to four pairs of lateral branches, the most posterior of which is some distance from the hinder end of the gut, thus forming a terminal blind sac. The intestinal branches do not anastomose, nor are the secondary branches numerous.

The brain holds a position one-twelfth the body length from the anterior end of the body, but owing to their indistinctness the course of the nerves, to which it gives rise, has not been determined.

In this species the testes, ventral in position, are clearly defined, but the sperm canals are totally invisible. The vasa deferentia are likewise somewhat ill-defined, but may be seen (Pl. XIII, fig. 16) in favorable specimens to arise about opposite the posterior end of the pharyngeal chamber and to extend anteriorly to a point not far behind the level of the mouth. Here they turn abruptly backward and inward to enter the seminal vesicle (Pl. XVII, fig. 37) at its antero-ventral extremity. The seminal vesicle is more or less heart-shaped, and is placed immediately in front of the pharynx and ventral to the tube leading from the pharyngeal cavity to the external mouth. Leaving the seminal vesicle anteriorly, the ejaculatory duct makes its way to the base of the penis where it receives a short duct from the granular gland. This last-named organ is small, spherical, and is located immediately in front of the seminal vesicle. The penis is very short, in some specimens rather abruptly pointed, and it opens into a chamber contained within the penis sheath, which in turn opens into the antrum masculinum. This last-named space communicates with the mouth.

The ovaries contain, during the breeding season, an unusually large number of ova and are accordingly very distinct, though the ducts connecting them with the uteri are invisible except occasionally in sections. The uteri (Pl. XIII, fig. 16) originate approximately half the distance from the ventral sucker to the posterior end of the main gut. From this point, where apparently they do not fuse

across the mid line, they extend forward skirting the gut as unbranched, swollen chambers often filled with a comparatively large number of ova. Opposite the posterior end of the pharyngeal pocket they bend inward and unite under the base of the pharynx. The resulting median duct is short and proceeds anteriorly and ventrally to the ample shell chamber which receives the ductules from many filiform glands (Pl. XVIII, fig. 37). Ventral to this point is the moderate antrum which opens to the exterior ventral to the base of the pharynx. Dorsal to the shell chamber a small zone of glandular tissue, staining darkly in Delafield's hæmatoxylin, surrounds the egg canal. What its function is it is impossible to determine. No uterus glands were observed in any of the whole mounts or sections, though considerable pains were taken to determine this point.

Genus ACEROS Long, 1884.

Body smooth. Mouth immediately behind the brain. Pharynx cylindrical. About 5 pairs of gut branches. Male sex pore immediately behind the mouth; female near hinder end of pharyngeal pouch. Tentacles lacking.

Aceros langi sp. nov.

A single representative of this species was taken on the southern shore of Monterey Bay, but concerning its habits or habitat we are without information. Its form in life was probably elliptical and measures 8 mm. in length by 6 in width. The ventral sucker (Pl. XII, fig. 5) is slightly posterior to the middle of the body. The anterior margin of the animal was slightly injured which prevents the precise determination of the exact location of the mouth with reference to it. However, the mouth may safely be said to be very close to the anterior end of the body. The penis is directed forward. There are no nuchal tentacles; marginal tentacles may have existed on the damaged portion, though no trace of them now remains. About fifty large eyes (text fig. 6) overlie the brain area that are roughly divided into two irregular clusters. No eyes have been seen on other regions of the body.

Fig. 6.—Eyes of *Aceros langi*.

The mouth (Pl. XVII, fig. 38) opens into the cylindrical pharyn-

geal pocket, which in the present instance contains a long and slender proboscis, protruded a short distance beyond the mouth opening. Posteriorly the pharynx leads into the capacious main gut which gives rise to five pairs of lateral intestinal branches together with an anterior terminal one. At the outset all of these branches are comparatively large and of fairly even caliber, but they soon become transformed into a branching, non-anastomosing system of rather narrow twigs. The sucker underlies the gut between the fourth and fifth pairs of lateral branches. Beyond the last pair the gut extends posteriorly to a point close to the posterior end of the body.

The brain is situated directly over the mouth, but as the nerves arising from it are seen with much difficulty, no serious attempt has been made to determine their distribution.

The testes are rather uniformly distributed ventrally, but the capillaries leading from them are invisible in the present specimen. The vasa deferentia (Pl. XII, fig. 5) arise at the end of the first body third, midway between the gut and the margin of the body, and converge anteriorly as simple though much swollen and convoluted ducts. Opposite the middle of the pharyngeal pocket they pass inward toward the mid line to fuse mesally at the point where the oval seminal vesicle is located. From this last-named organ a short ejaculatory duct extends anteriorly to the penis situated immediately behind the mouth. The male reproductive pore could not be determined with absolute certainty. Certain features suggest that it opens into the mouth, and on the other hand there are faint indications that it is situated immediately behind the mouth, yet independent of it. A granular gland was not distinguished.

The ovaries are dorsal. The uteri (Pl. XVII, fig. 38), originating at the level of the sucker, are so greatly inflated by multitudes of eggs that they exceed the main gut in caliber. Between the second and third pairs of gut branches the uteri fuse and send forward a short, slender duct, the vagina, which communicates with the exterior close to the posterior end of the pharyngeal pocket.

Contrary to the rule, no uterus glands could be detected where, according to Lang, one pair should exist.

ANCILIPLANA gen. nov.

Body broadly elliptical. Tentacles large, without eyes; cerebral eyes in two distinct groups. Pharynx small; main gut slender with 8 pairs of branches, highly anastomosed. Vasa deferentia and uteri anastomosed. No uterus glands.

Anciliplana graffi sp. nov.

Several specimens of this species were collected in Monterey Bay and along the adjoining coast. The largest specimen is broad oval in outline and measures 18 mm. in length by 13 in greatest width. No color notes were obtained. The ventral sucker is slightly anterior to the middle of the body. The mouth is placed one-sixth the length of the animal from the anterior margin. The penis is directed forward. The tentacles are large, broadly triangular outgrowths of the anterior margin of the body extending posterior to the brain. Small eyes (text fig. 7) occur above the brain in two imperfectly separated groups, No eyes occur on or about the tentacles.

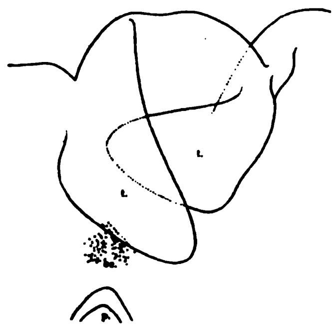


Fig. 7.—Eyes and tentacles of *Anciliplana graffi.*

The pharynx (Pl. XVII, fig. 35), more or less conical in form, leads into the main gut which communicates in turn with an average of eight pairs of intestinal branches. These plainly anastomose at the outset and probably continue to do so even to the margins of the body.

The brain is located immediately in front of the pharyngeal pocket, but other details of the nervous system have not been determined. The testes are ventrally disposed, and clearly defined sperm capillaries are totally invisible in cleared specimens. The vasa deferentia (Pl. XVII, fig. 35) first appear opposite a point slightly behind the sucker. Their many ramifications finally converge anteriorly to form the large single ducts (Pl. XVI, fig. 31) which bend sharply backward behind the penis and curve inward to form a semicircular transverse canal. From the centre of this arch a very short duct pursues a direct course to the large and spherical seminal vesicle. The ejaculatory duct leaves the vesicle at the opposite side and soon enters the base of the penis. The granular gland, communicating with this canal at the base of the penis, is elliptical in outline and lies between the penis and the seminal vesicle.

The ovaries are dorsal and the uteri, which plainly anastomose (Pl. XVII, fig. 35) from the first, probably connect with the former by means of a system of anastomosing capillaries. The web-like uteri extend lateral to the main gut throughout the greater part of its course, and posterior to the seminal vesicle converge (Pl. XVI,

fig. 31) to form the single short, female duct, the vagina, which opens to the exterior immediately behind the arc of the vasa deferentia.

Genus **EURYLEPTA** Ehrenberg, 1831.

Pharynx cylindrical, about 5 pairs of intestinal branches without anastomoses. Male sex opening beneath base of pharynx.

Eurylepta aurantiaca sp. nov.

This species is fairly common in Monterey Bay and the neighboring coast where it occurs under stones or crawling along the bottom in comparatively shallow water. It is sluggish in its movements and clings most tenaciously when an attempt is made to remove it. The largest specimen is broadly oval in outline (Pl. XIV, fig. 18) and measures 15 mm. in length by 10 mm. greatest diameter. Generally speaking, the color of the dorsal surface is yellowish-pink or salmon tint except along the mid line where a bright pink streak extends from the eyes to the posterior end of the main gut. Minute white specks are uniformly distributed over the entire dorsal surface. On the ventral side of the animal pigment is lacking, and the opaque, white somatic muscles are of such thickness that they wholly obscure all of the internal organs.

The ventral sucker is slightly behind the middle of the body. The mouth (Pl. XIV, fig. 18) is placed somewhat less than one-sixth the length of the body from the anterior margin of the body. The penis is directed forward. Nuchal tentacles are lacking, and the marginal tentacles (text fig. 8) are rather short, stout outgrowths that, when the animal is at rest, are folded back on the dorsal surface. Numerous eyes are distributed on the tentacles in two distinct clusters with approximately 70 eyes in each, while two fairly well-defined oval groups, each with about 50 ocelli, occur dorsal to the brain.

Fig. 8.—Eyes of *Eurylepta aurantiaca*.

The mouth (Pl. XIV, fig. 18) opens into a spacious pharynx, appearing like an inverted shield in outline, with a length equalling one-sixth that of the body.

Posteriorly the pharyngeal cavity communicates with the spacious chamber of the main gut which extends backward close to the posterior end of the animal, giving rise to seven or eight pairs of intestinal branches during its course. These last-named structures are at first of even caliber, but soon become swollen and greatly constricted, giving the impression of a dichotomously arranged system of large spherical vesicles.

The brain is situated immediately in front of the pharynx, but otherwise the details of the nervous system have not been determined clearly.

The testes are ventral and in some cases are united by anastomosing sperm capillaries (Pl. XIV, fig. 18) that, on the other hand, unite with the vasa deferentia. The latter originate at the level of the sucker, and, pursuing a tortuous course as they proceed anteriorly, they finally swing inward at a point not far behind the pharyngeal pocket. Here they unite (Pl. XVII, fig. 34) and as single tube proceed anteriorly into the base of the penis. At the same point where the penis receives this median duct it also communicates with the outlet of the ample and elliptical granular gland. There is no seminal vesicle. The penis is moderately thin walled and inflated and is guarded by a closely enveloping sheath which in turn lies at the base of an antrum masculinum of average proportions.

The ovaries are dorsal and in some specimens are clearly united by a system of capillaries that unite with the uteri close to the outlet of the so-called uterus glands. In a general way the uteri (Pl. XIV, fig. 18) may be said to arise midway between the sucker and the posterior end of the gut, and from this point to extend forward, anastomosing somewhat, to turn sharply inward opposite a point midway between the sucker and the anterior gut-end. Here they fuse (Pl. XVII, fig. 34) into a median duct, the vagina, that leads to a small antrum femininum and to the exterior immediately behind the point of fusion of the vasa deferentia. In the location where each uterus commences to swing in toward the mid line, it is joined by a short duct leading from a well-developed uterus gland of varying size according to the proximity of the breeding season. They may be almost spherical or contracted into a thin crescent or, as appears to be a more usual state, elliptical. The duct leading from it arises from the inner surface of the gland.

EURYLEPTODES gen. nov.

Pharynx relatively small; main gut slender with 7 to 8 anastomosing

branches. Male sex pore at base of penis. Vas deferens simple or anastomosed; uterus anastomosing; no uterus glands.

Euryleptodes cavicola sp. nov.

Nine specimens represent this species taken at various points along the shores of Monterey Bay. It occurs, at moderately low-tide mark, on the under surface of loose boulders or concealed in crevices of the bottom rock or among the holdfasts of seaweeds. Its movements are generally slow and deliberate, never sufficiently vigorous to enable the animal to swim. The texture of the body is very delicate, and three of the specimens show extensive signs of partially regenerated injuries.

The color of the dorsal surface is greenish-white, irregularly marked with small, round white spots and dark red lines of varying length and direction. As a general thing, there are five fairly well-defined transverse lines, the first of which is immediately behind the tentacles and the last not far from the posterior end. Two irregular longitudinal stripes, at times ill-defined, commence at the first transverse line at points midway between the edges of the body and the median line and extend backward to the last transverse line. The ventral surface of the body is unpigmented.

The largest specimen is broadly oval (Pl. XVI, fig. 29) and measures 31 mm. in length by 20 mm. in greatest width. The ventral sucker is almost exactly in the centre of the body. The mouth is located about one-sixth the length of the animal from the anterior end. The penis is directed forward. Nuchal tentacles are wanting, but the marginal tentacles (text fig. 9) are very large, fleshy outgrowths of the anterior body edge. Numerous small eyes are scattered over the tentacles and even between them; and a group of somewhat larger eyes, divisible into two closely approximated clusters of about seventy each, overlies the brain.

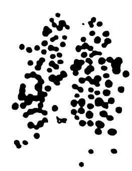


Fig. 9.—Eyes of *Euryleptodes cavicola*.

No especially noteworthy features have been noted in connection with the digestive system. The mouth (Pl. XVI, fig. 29) opens into the acorn-shaped pharynx which has a length equal to about one-ninth that of the body. Posteriorly it leads into the main gut chamber which originates seven pairs of lateral intestinal branches as a general thing. These are of rather even caliber at their source, but soon become deeply constricted and give rise to a distinct anastomosing system.

The brain is located considerably nearer the mouth than the anterior body margin. Both it and the nerves to which it gives rise are fairly distinct, but in their distribution conform closely to the well-known polyclad type.

The testes are ventral, of moderate size and are clearly united by means of a system of sperm capillaries, that apparently do not anastomose, though this is not definitely established. The vasa deferentia (Pl. XVI, fig. 29) arise close to the posterior end of the gut and skirt the external borders of the uteri. Near the anterior end of the uteri these canals swing abruptly inward and fuse to form a very short, median duct (Pl. XV, fig. 28) which at once enters the large spherical seminal vesicle. Leaving this last-named organ at its opposite end, the slender ductus ejaculatorius passes into the base of the penis. At the point where the latter receives the ductus the rather large, oval granular gland makes its connection. In the clearest of the total mounts the penis and its ducts appeared to arch backward and the male aperture was accordingly posterior to it, though this may have been due to contractions due to the killing fluids. The penis and male pore are placed about one-fourth of the length of the animal from the anterior margin of the body. There is an antrum masculinum of average size.

The ovaries are dorsal and are united by an anastomosing system of canals with the uteri. These last-named organs meet in the mid line directly behind the mid gut (Pl. XVI, fig. 29), though they apparently do not fuse. Extending forward outside of the borders of the gut they anastomose frequently, particularly near the anterior end where several convergent branches fuse (Pl. XV, fig. 28) to form the short vagina. This latter organ passes anteriorly a very short distance and opens to the exterior immediately behind the seminal vesicle.

Euryleptodes pannulus sp. nov.

But one specimen of this species has ever been seen by us. It was brought into the laboratory together with a large number of other

shore invertebrates, and we could obtain no data regarding its habitat; and as it came into our hands in a preserved state, no color notes are available. The body is broadly elliptical in outline and measures 12 mm. in length by 8 in width. The mouth is placed about one-fifth the length of the body from the anterior margin. The penis is directed forward. The tentacles are lacking or are exceedingly rudimentary,[2] and in the position usually occupied by marginal tentacles numerous eyes appear to be the only well-defined sense organs. Other eyes, of somewhat larger size, also occur over the brain in two narrow, closely approximated clusters. Together these are no wider than the brain, though they are considerably longer.

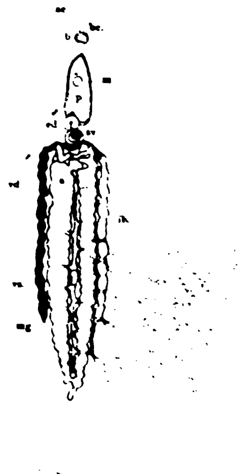


Fig. 10.—Ventral view of *Euryleptodes pannulus.*

The mouth is situated in the anterior fifth of the animal and opens into a cylindrical pharynx, whose length is slightly less than one-sixth that of the animal. Posteriorly the pharynx leads into the main gut chamber, of rather slender outline and with seven or eight pairs of lateral intestinal branches. These distinctly anastomose from the first.

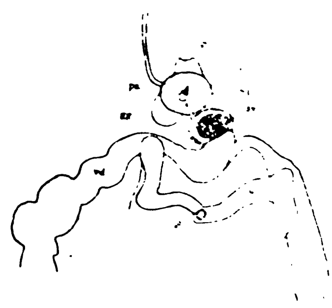


Fig. 11.—Central reproductive apparatus of *Euryleptodes pannulus.*

The brain is situated half-way between the mouth and the anterior body margin, but the imperfect preservation of the animal renders it impossible to trace even the main nerves.

The testes are ventral and the ducts from them may possibly form an anastomosing system, though this is far from being proved. The large vasa deferentia, originating opposite a point be-

[2] It is possible that the peculiar shape of the tentacle region may be due to injury and partial regeneration.

tween the sucker and the posterior end of the gut, proceed anteriorly and after skirting the uteri sweep inward to fuse in the mid line. The canal thus formed immediately plunges through the spherical seminal vesicle and as a slender ejaculatory duct directs its course to the penis. The granular gland is oval, of moderate size, and opens into the ejaculatory duct near the penis.

The ovaries are dorsal. The uteri extend posteriorly to the same distance as the main gut, behind which they fuse to form a short median branch. Anteriorly they extend between the gut and the vasa deferentia, and converge to open in the mid line a short distance posterior to the seminal vesicle.

Euryleptodes phyllulus sp. nov.

This species is represented by several individuals taken on the southern shore of Monterey Bay. The largest specimen is elliptical in outline (Pl. XVI, fig. 33) and measures 28 mm. in length by 18 mm. in width. Color notes are wanting. The sucker is slightly anterior to the centre of the body. The mouth is about one-eighth the length of the body from the anterior end near the apex of the pharyngeal pocket. The penis is directed forward. The tentacles (Pl. XVI, fig. 33) are fleshy outgrowths of the anterior margin of the body, extending posteriorly as far as the brain. On and between the tentacles are medium-sized eyes (text fig. 12) which assume no definite arrangement, and they also occur over the brain in a triangular group, of about 150 ocelli, which are faintly divisible into two clusters.

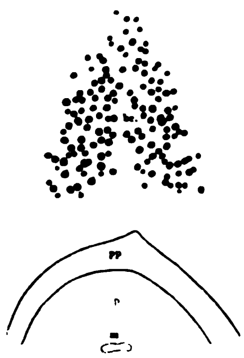


Fig. 12.—Eyes of *Euryleptodes phyllulus.*

The mouth (Pl. XVI, fig. 33) opens into the roughly triangular-shaped pharynx from which the main gut proceeds posteriorly, giving rise to about seven pairs of intestinal branches. These last-named organs are often swollen at their bases, but more distally gradually decrease in caliber and form an elaborately anastomosing system.

The brain is situated immediately in front of the pharyngeal pocket, but the other details of the nervous system are well-nigh invisible in surface mounts.

The testes (Pl. XVI, fig. 33) are liberally distributed over the ventral half of the animal, but no trace has been seen of the connecting sperm capillaries. The vasa deferentia extend posteriorly

as far as a point midway between the sucker and the posterior end of the gut and laterally half-way to the margin of the body. Not far behind the pharyngeal pocket the meshes of the vasa deferentia converge (Pl. XV, fig. 25) to form a pair of ducts which pass abruptly inward to enter the seminal vesicle from the rear. This last organ is large, oval, and the ejaculatory duct leaving its anterior border passes quickly to the base of the penis, communicating with the exterior immediately below the posterior margin of the pharyngeal sheath.

The ovaries (Pl. XVI, fig. 33) are dorsal, but the ducts connecting them are invisible in total mounts. The uteri, on the other hand, are clearly defined and fuse behind the posterior end of the gut, forming a short median canal. From this point they extend anteriorly on either side of the main gut for nearly its entire length and open to the exterior immediately below the posterior end of the seminal vesicle. Numerous radiating ductules (Pl. XV, fig. 25) from the shell gland centre in the neighborhood of the vagina.

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Explanation of Abbreviations used in Figures.

ab	anterior intestinal branch.	od	oviduct.
ae	marginal eyes.	os	ovaries.
af	antrum-femininum.	p	pharynx.
ag	accessory gland.	pp	pharyngeal pocket.
ai	intestinal anastomoses.	ps	penis.
am	antrum-masculinum.	pss	penis sheath.
b	brain.	pt	dorsal pits.
bc	bursa copulatrix.	sa	pouch of antrum-masculinum.
be	brain (or cerebral) eyes.	sc	shell chamber.
dp	dorsal pits.	sg	shell glands.
ed	ejaculatory duct.	sv	seminal vesicle.
gg	granular-gland.	t	marginal tentacles.
gs	gland-like structures.	te	nuchal tentacle eyes.
ib	lateral intestinal branches.	ts.	testes.
im	inner mouth.	u	uterus.
m	mouth.	ug	uterus-gland.
mg	mid-gut.	v	vagina.
nt	nuchal tentacles.	vd.	vas deferens.
o	ova.	vs	ventral sucking disk.

Explanation of Plates XII–XVIII.

All of the figures were drawn by E. A. McGregor.

Plate XII.—Fig. 1.—*Leptoplana timida*, ventral view.
Fig. 2.—*Stylochoplana gracilis*, ventral view.
Fig. 3.—*Leptoplana rupicola*, ventral view.
Fig. 4.—*Leptoplana saxicola*, ventral view.
Fig. 5.—*Aceros langi*, ventral view.
Fig. 6.—Reproductive apparatus of *Stylochoplana gracilis*.
Fig. 7.—*Phylloplana litoricola*, ventral view.

Plate XIII.—Fig. 8.—*Leptoplana inquieta*, ventral view.
Fig. 9.—Tentacle and cephalic eyes of *Planocera burchami*.
Fig. 10.—Penis of *Leptoplana rupicola*.
Fig. 11.—Section through dorsal papilla of *Licheniplana lepida*.
Fig. 12.—Central reproductive apparatus of *Leptoplana timida*.
Fig. 13.—Penis, granular gland and seminal vesicle of *Leptoplana rupicola*.
Fig. 14.—Central reproductive apparatus of *Leptoplana inquieta*.
Fig. 15.—Portion of male reproductive apparatus of *Leptoplana rupicola*.
Fig. 16.—*Stylostomum lentum*, ventral view.

Plate XIV.—Fig. 17.—*Licheniplana lepida*, ventral view.
Fig. 18.—*Eurylepta aurantiaca*, ventral view.
Fig. 19.—Brain and eyes of *Leptoplana saxicola*.
Fig. 20.—Brain, tentacles and eyes of *Stylochoplana gracilis*.
Fig. 21.—Dorsal and ventral nervous systems of *Leptoplana saxicola*.

Plate XV.—Fig. 22.—Central reproductive apparatus of *Leptoplana rupicola*.
Fig. 23.—Same of *Phylloplana litoricola*.
Fig. 24.—Same of *Planocera californica*.
Fig. 25.—Same of *Euryleptodes phyllulus*.
Fig. 26.—Longitudinal vertical section through central reproductive apparatus of *Stylochoplana gracilis*.
Fig. 27.—*Planocera burchami*, ventral view.
Fig. 28.—Reproductive apparatus of *Euryleptodes cavicola*.

Plate XVI.—Fig. 29.—*Euryleptodes cavicola*, ventral view.
Fig. 30.—Central reproductive apparatus of *Leptoplana saxicola*.
Fig. 31.—Same of *Anciliplana graffi*.
Fig. 32.—Vertical longitudinal section through penis of *Planocera californica*.
Fig. 33.—*Euryleptodes cavicola*, dorsal view.

Plate XVII.—Fig. 34.—Central reproductive apparatus of *Eurylepta aurantiaca*-
Fig. 35.—*Anciliplana graffi*, ventral view.
Fig. 36.—Central reproductive apparatus of *Licheniplana lepida*.
Fig. 37.—Longitudinal section through reproductive apparatus of *Stylostomum lentum*.
Fig. 38.—Central reproductive apparatus of *Aceros langi*.

Plate XVIII.—Fig. 39.—*Planocera californica*, ventral view.
Fig. 40.—Eyes of *Stylostomum lentum*.
Fig. 41.—Section through eyes and nuchal tentacles of *Planocera californica*.
Fig. 42.—Tentacle and cephalic eyes of *Phylloplana litoricola*.
Fig. 43.—Eyes of *Leptoplana inquieta*.
Fig. 44.—Central reproductive apparatus of *Planocera burchami*, **immature** individual.

OCTOBER 1.

MR. CHARLES MORRIS in the Chair.

Twenty persons present.

The Publication Committee reported the reception of papers under the following titles:

"A revision of the genera and species of the group Mogoplistii (Orthoptera: Grillidæ) found in America north of the Isthmus of Panama," by James A. G. Rehn and Morgan Hebard (June 6).

"On the Orthoptera found in the Florida Keys and extreme southern Florida, I," by James A. G. Rehn and Morgan Hebard (June 6).

"A catalogue of Japanese Cephalopoda," by S. Stillman Berry (June 15).

"The experimental method of testing the efficiency of warning and cryptic coloration in protecting animals from their enemies," by W. L. McAtee (June 15).

"Statistical studies on the variation of the wing-length of a butterfly of the subfamily Satyrinæ," by T. Fukuda (June 15).

"Silicified wood from the Triassic of Pennsylvania," by Edgar T. Wherry, Ph.D. (June 21).

"Age and correlation of the 'New Red' or Newark group in Pennsylvania," by Edgar T. Wherry, Ph.D. (June 21).

"A new Synallaxis," by Witmer Stone (July 25).

"New Polyclads from Monterey Bay, California," by Harold Heath and Ernest B. McGregor (August 14).

"Observations on the structure of some coral beds in the Hamilton Shale," by Burnett Smith (August 15).

"A new species of Vertigo from Florida," by E. G. Vanatta (August 22).

These had been reported on favorably for publication in the PROCEEDINGS.

A paper entitled "Experimental studies in nuclear and cell division in the eggs of Crepidula," by Edwin G. Conklin (August 5), was accepted as a contribution to the commemorative volume of the JOURNAL.

The deaths of the following members were announced:

Caleb J. Milne, July 1, 1912.
Horace Bellows, M.D., July 12, 1912.
Thomas S. Parvin, July 15, 1912.
Horace Howard Furness, August 12, 1912.

The death of Rudolf Hoernes, a correspondent, August 22, 1912, was also announced.

A portrait in oil of the President, by Raditz, was presented. The thanks of the Academy were voted to Dr. Dixon for his very desirable gift.

Dr. Philip P. Calvert made a brief report as one of the Academy's representatives at the Second International Entomological Congress at Oxford.

October 15.

Mr. Charles Morris in the Chair.

Eight persons present.

The following papers were accepted for publication in the commemorative volume of the Journal:

"A study of the variation and zoogeography of Liguus in Florida," by Henry A. Pilsbry, Sc.D. (August 3).
"Analyse der Süd-Amerikanischen Heliceen," by H. von Ihering (October 15).

J. W. von Wijhe was permitted to withdraw his paper on Amphioxus.

The following were elected members:

Ernest Comly Dercum,
Warren Matthews Foote.

November 5.

The President, Samuel G. Dixon, M.D., LL.D., in the Chair.

Eight persons present.

The death of the Rev. Edward Craig Mitchell, a member, on December 8, 1911, was announced.

NOVEMBER 19.

The President, SAMUEL G. DIXON, M.D., LL.D., in the Chair.

Forty-nine persons present.

The death of Clement A. Griscom, a member, on November 10, 1912, was announced.

The reception of a paper entitled "Notes on a prehistoric race of Yucatan," by R. W. Shufeldt, M.D. (November 12), was reported by the Publication Committee.

DR. PHILIP P. CALVERT made an illustrated communication on waterfall-inhabiting dragonflies of Costa Rica.

Horace E. Smith was elected a member.

The following was ordered to be printed:

NOTES ON A PREHISTORIC RACE OF YUCATAN.

BY R. W. SHUFELDT, M.D.

During the month of June, 1912, I received, through Mr. E. W. Nelson, of the Biological Survey of Washington, D.C., from my son, Mr. P. W. Shufeldt, who for several years has been a resident of Campeche, Yucatan, a consignment of some human remains, which he had collected in that country. Mr. Nelson had received these with other biological material which my son had sent him, and I have pleasure in thanking him here for his courtesy in transmitting them.

About a month after this material came into my hands, my son wrote me an interesting letter, in which he requested me to make such use of all he had sent as I thought best, and, further, he gave a brief account of the region in which he had collected the aforesaid material, and other notes.

This material I found to be the broken and fragmentary remains of a human skeleton or skeletons, all of which I shall fully describe further on in this contribution.

From my son's letter I transcribe the following information, which I give in his own words: "As you perhaps know, the peninsula of Yucatan—or at least such part of it as is familiar to me—is evidently formed of upheaved sea-bottom, and that within comparatively recent times. It is now covered with a thin cap of decomposed vegetable mould, and more or less heavily forested in the less civilized portions. At the time of this upheaval, there were formed a series of low, rolling hills, with more or less level swales in between. The part of which I write is almost destitute of running streams or rivers, and all the available fresh water is that which is collected during the rainy season in the lower depressions in the swales, which are known as 'aguadas.'

"The land which is being worked by the company with which I am connected comprises something over a million and a half acres, situated in the southern half of the District of Champoton. With this land I am more or less familiar, and it was here that the human remains were collected. At the present time, there are a few isolated

villages of native Indians belonging to the Maya race, who have inhabited this section as far back as the memory of man. As far as I have been able to find out, they have absolutely no folk-lore or traditions relative to the vast population which preceded them. They are a dying race, with little moral or physical stamina left, and, beyond a very ordinary basket-weaving, no native industry.

"Now as to the prehistoric race—or races—which at one time covered this vast country, you would hardly believe the amount of ruins that remain; it would be entirely within the truth to say that *all* the high land has been occupied by dwelling houses, and beyond a doubt the population at one time fully equalled the most congested parts of India. As far as I have seen, there were no important cities; rather the entire country was one swarming mass of people. Often, about the larger aguadas, may be found such heaps of ruins as would lead one to believe that temples or principal buildings were situated there. I have personally seen but one building standing; but that is enough to give an idea of the very substantial nature of the buildings—or at least of some of them.

"Without exception, they were of stone faced with squared limestone placed in mortar—the walls being of extreme thickness and formed of rubble—the dressed stones facing on the outside, the rooms on the inside being plastered, and, evidently, in many cases, this plastering was decorative and painted.

"In the case of the house still standing, the flat Maya arch is used, and there are both doors and windows. The building was of at least two stories, and perhaps three. Besides these stone structures—the remains of which, as I say, are without number—there are many evidences of even more numerous houses of a more perishable nature where permanent structure was only used in the foundations and flooring.

"Almost without exception, in the six or eight structures which I have had dug up, remains of human bones were found; but all these are very much decomposed and extremely brittle.

"Other objects which have been found in these old ruins or 'cuyos,' as they are called, and of which I have collected specimens, are earthen pots, both for cooking and ornament. These are of numerous grades—some as fine as modern Guadalajara pottery, others of much coarser grade. As to decorations, there are examples of glaze in red, yellow, or a very dark brown, both painted decorations and embossed on the clay. There are also remains of very large jars which were of a coarse grade. Among other clay objects

[illegible] are representations of various animal forms and figures of [illegible]. [illegible] of the same character, and of very inferior grade of pottery, [illegible] showing [illegible] and [illegible] The upper teeth are always showing, sometimes in an exaggerated form. [illegible] These [illegible] forms [illegible] with the foregoing characters.

Among the stone implements I have found [illegible] axes of several kinds of stone; arrow- and spear-heads of very superior workmanship; grinding stones for corn or 'metates'—of hard stone as well as of the stone used at the present time. Without exception, however, these metates are very small, with short legs.

"I have also a number of smaller stone implements, of which one can only guess the use. Besides the aforementioned specimens, I have one bone implement, such as might be used for husking corn. Up to the present time there has not been a single metal implement or ornament found here.

"It will give you some idea as to the age of this civilization, when I tell you that nearly all the available ground for building, in such areas as I have been able to study—that is, where we have cleared away the forests—has, without doubt, been worked over by hand, as evidenced by buildings, or rather the remains of them: little piles of stones and trash, evidently gathered ready for building, as well as broken stones without number. All, or most, have evidently been tested as to their suitability for stone implements.

"In many places, without evident remains on the surface, there is, upon excavation, as much as a meter of soil containing broken pottery, pieces of broken stone implements, etc., and often, also, remains of human skeletons.

"From my limited observation and knowledge of such subjects, I came to the following conclusions in regard to these prehistoric people, whoever they were: that the density of population was equal to or beyond anything existing to-day upon the face of the earth, outside of the large, modern cities; that they were well advanced in the art of building; that they were unfamiliar with the use of metals (?); that there has been not only one highly developed people, but two or three, each building upon the ruins of the former; that they had highly developed the art of clay-burning and glazing; that they had outside communication with a people inhabiting the highlands of Guatemala or Mexico or some other people living in the volcanic mountain country, and that, at least, they cultivated cotton

and corn. How or where they secured their supply of water, who they were, or where they went—each may form his own idea."

When I came to examine the material referred to at the commencement of this article, I found that it represented one human skeleton and a few parts of a second one, such as an extra mastoid process of a temporal bone of the right side of a skull. There may be other pieces belonging to this latter skeleton, but of that I am not quite sure, as the fragmentary condition of the whole renders it practically impossible to decide as to that. The extra mastoid process is larger than the other two at hand, and apparently came from the skull of a larger individual than the rest would indicate. It is probably from the skull of an adult male subject.

There are some 150 pieces or more of the skeleton to which the balance of the material belongs. Apart from some of the phalanges of the hands and feet and other small bones, these are all more or less imperfect—in most cases extremely so.

As bones, they all exhibit the usual evidences of great age and, in some instances, of having been broken up long ago—as in the case of certain bits of the calvarium, where the fractured edges are considerably worn, thus rendering it impossible to associate them correctly. All of these pieces are of a very pale clay color, almost white, and extremely friable and brittle. Even the shafts of the largest long bones may easily be broken with one's hands alone.

The only restorations that it was possible for me to make are here shown in Plate XIX and in Plate XXI, fig. 17. The skull and mandible are shattered into many little bits, and such bones as the sphenoid and others are broken up to such an extent as to make it difficult to recognize the parts—even with a perfect skull at hand for guidance. Except a very few fragments, the entire vertebral column and pelvis are missing, and I find no pieces that would suggest any portion of the hyoid bone. One clavicle is in fairly good condition (Plate XX, fig. 8), but most of the ribs are very fragmentary. No part of the sternum seems to be present, and if it is, the parts have been crumbled beyond recognition. This appears to be likewise true of the scapulæ.

With respect to the long bones of the extremities (Plate XXI, figs. 17–22), I find the middle thirds of the shafts of the femora, with their extremities and the rest, missing. There are also similar remains of the humeri, the ulnæ, the radii, tibiæ, fibulæ, and so on; but no other bone nearly as perfect as the humerus I restored in Plate XXI, fig. 17. The crests of the tibiæ are far from being what

we would call sharp. Some of the shafts of these long bones, especially the radii and tibiæ, exhibit a pathological condition, through which necrosis has followed and destroyed some of the osseous tissue of the shafts. It is quite possible that this was due to syphilitic disease or to some other malady, but I believe it to be due to syphilis.

Judging from the slenderness and general form of these bones, I would say that they belonged to a skeleton of a female subject; and, owing to the fact that the clavicle exhibits no distortion or augmentation of size, to an individual who was not accustomed to severe labor of any kind worth mentioning. Further, this person must have been between twenty-five and thirty years of age, which I assume to be the case from my examination of the seven (7) teeth I find with the remains (Plate XX, figs. 3 and 4, *a*, *b*, *c*, *d* and *e*). There is also a small first bicuspid with half of its fang broken off, which is not figured. All of these teeth are wonderfully sound and perfect, exhibiting no evidences of caries whatever or attrition due to the wear of age.

Only a few of the bones of the carpus, or tarsus, are present; these are more or less imperfect and present nothing of special interest.

In Plate XX, figs. 9–16, I give some of the phalanges of the hands and feet. These are selected from quite a number which my son collected with the rest of this skeleton, and from their general form and appearance seem to have belonged to an individual who, in so far as the feet are concerned, never compressed these parts in any way whatever and yet walked a great deal. The individual bones are stout, strong, and somewhat broad, transversely for their lengths (Plate XX, fig. 10).

If we may judge from what we have of the skull of this subject (Plate XIX, fig. 1, and Plate XX, fig. 3), it is fair to assume that the possessor of it had a rather large cranial capacity; that the parietal, supraoccipital and temporal walls were not particularly thick; while, as a matter of fact, the tables are thin and the diploic tissue not especially abundant. In the lambdoid suture there is at least one "Wormian bone" present, and there may have been others, although I attach no great significance to the fact. The "anterior nasal spine" was rather prominent, as is the case in some of the lower races of mankind.

On the internal table of the cranial vault, the eminences and depressions for the lodgement of the convolutions of the cerebrum

are well marked, but not sufficiently well preserved to indicate the amount or complexity of the cerebral substance. The lateral sinuses, the grooves for the meningeal arteries, and the Torcular Herophili are all easily made out, and there is every indication that the foramen magnum was unusually large.

Although fragmentary, this material is of no little importance, especially when taken in connection with what my son has pointed out in his above-quoted letter. It is to be hoped that a great deal more material will come to hand from the same country, including such objects as pottery, weapons, tools, ornaments, idols, etc., as well as a series of good photographs of remains of buildings, character of country and other data so as to furnish as complete a report as possible on this prehistoric people and the little-known country they inhabited.

Explanation of Plates XIX, XX, XXI.

[All the figures in the three plates are reproductions of photographs made by the author direct from the specimens.]

Plate XIX.—Fig. 1.—Portion of the left side of the skull, broken into five (5) pieces, and restored by the author. *tm.*, temporal bone; *zyg.*, zygomatic process of temporal; *ms.*, mastoid process; *c.*, condyle for atlas; *p.c.f.*, posterior condyloid foramen; *oc.*, occipital bone, broken into four (4) parts; *s.s.*, squamosal suture; *l.s.*, lambdoid suture. The longest diameter of the portion of this skull here shown, taken from the end of the zygomatic process to the occiput, measures in the specimen 16.2 cms.; the same diameter measures on the figure 14.3 cms. The ratio gives the amount of reduction.

Plate XX.—Fig. 2.—One of the cervical vertebræ seen from above. The spinous process broken off, together with lower border of lamina. This is probably the fourth to the sixth cervical vertebra, from the skeleton of not a large subject. Sex unknown. I have not compared it with the vertebræ of this part of the spine in the skeletons of known subjects. Transverse diameter of body in specimen 1.9 cms.; in this figure on the plate, 1.6 cms. This will give the ratio of reduction for all the other bones shown on this plate.

Fig. 3.—Fragment of superior maxillary bone seen on direct lateral aspect; first and second molar teeth *in situ*.

Fig. 4.—Five other teeth, a canine (which belonged to the bone shown in fig. 3) (*d*); a first bicuspid (*e*); and three molars (*a*, *b*, and *c*). All, save the canine, probably belonged to the other side of this jaw.

Fig. 5.—First metacarpal bone of left hand; lateral aspect. The distal extremity is toward the centre of the plate. In the specimen, the longitudinal axis measures 4.4 cms.

Fig. 6.—Vertebral extremity of the second rib of the right side, with a small part of the shaft. Head fractured off.

Fig. 7.—Portion of jaw; ramus of left side, with condyle and coronoid process perfect. Inner aspect, showing process overhanging inferior dental foramen.

Fig. 8.—Clavicle of left side, anterior aspect; sternal and acromial extremities broken off. The characters of this bone indicate that it belonged to a female subject, or at least to a person who was not accustomed to perform severe and continuous labor.

Fig. 9.—First phalangeal joint, minimus digit, left hand, palmar aspect. The distal extremities of all the phalangeal joints shown in the plate are directed upwards, with the exception of the one placed horizontally (fig. 13).

Fig. 10.—First phalanx of annularis digit of left hand, dorsal aspect. The specimen is perfect and 3.7 cms. in length.

Fig. 11.—Fourth metacarpal, left hand, dorsal aspect. Length of specimen, 4.9 cms.

Fig. 12.—First phalanx of second toe of right foot, seen on dorsal surface.

Fig. 13.—First phalanx of minimus digit of left hand, dorsal aspect.

Fig. 14.—Third metatarsal of left foot, dorso-inner-lateral aspect.

Fig. 15.—Second metatarsal of the left foot, internal surface.

Fig. 16.—Second metatarsal of the right foot, internal surface.

Plate XXI.—Fig. 17.—Shaft of right humerus, posterior surface, extremities imperfect, olecranon depression not perforated. Restored by the author from three fragments in the collection. Extreme length of specimen, 25.6 cms.

Fig. 18.—Proximal moiety of left humerus, posterior surface (probably from the skeleton of the same individual).

Fig. 19.—Part of the shaft of the left tibia, anterior surface. Proximal moiety with extremity missing.

Fig. 20.—Part of the shaft of the right tibia, anterior surface. Proximal moiety with extremity missing (probably from the skeleton of the same individual). The peculiar excoriation of the bone in the case of these two tibiæ indicate possible disease (syphilis?).

Fig. 21.—Proximal end of left radius, including head.

Fig. 22.—Proximal end of right radius, including head. Reduced about one-third.

DECEMBER 17.

The President, SAMUEL G. DIXON, M.D., LL.D., in the Chair.

Twenty-seven persons present.

DR. THOMAS H. FENTON, the Chairman of the Library Committee, called attention to a copy of the Centenary volume of the JOURNAL (XV) placed on the table by the Publication Committee in commemoration of the meeting held last March to celebrate the one hundredth anniversary of the founding of the Academy. He commented on the typographical merits of the volume, the value of its contents, and the promptness of its publication.

He then offered the following, which was unanimously adopted:

Resolved, That it is the sense of this meeting that the sincere thanks of the Academy are due to Dr. EDWARD J. NOLAN for his untiring zeal in the preparation, compilation, and editing of the splendid memorial volume presented to-night, and for its extraordinarily prompt completion.

The reception of papers under the following titles was reported by the Publication Committee:

"The Protoconch of Acmæa." By Will F. Thompson (December 14).

"Fauna of the Gatun Formation, Isthmus of Panama—II." By A. P. Brown and H. A. Pilsbry (December 17).

The following were ordered to be published:

FAUNA OF THE GATUN FORMATION, ISTHMUS OF PANAMA—II.

BY AMOS P. BROWN AND HENRY A. PILSBRY.

The collection reported in this paper was obtained by Professor William B. Scott in 1911.[1] It comprises materials from the following sources:

1. *Fossils from the oyster-shell areas in the Black Swamp near Mount Hope (Monkey Hill).* This material consists of coral and coralline fragments, with a considerable molluscan fauna, including the oysters which are the distinguishing shells of these shell areas. The bed lies about 4 feet above the present sea level, and is doubtless the same as that encountered in digging for sewers, etc., in the streets of Colon. Among the Mollusca the recent species predominate, though some species found in this assemblage seem to be extinct. It must be remembered, however, that the recent fauna of this part of the coast, aside from the strictly littoral forms, is very imperfectly known, and hence some of these supposedly extinct forms may be found living. In any case, it does not seem probable that this bed can be older than Pleistocene. The species will be considered, along with those of lot 2, in another paper.

2. *From the oyster-shell areas in the black, unconsolidated mud, unconformable on the Gatun Formation, found at the lower end of the Gatun Locks.* This mud extends from a few feet below sea level to about 10 feet above it. The specimens collected consist of shells of *Ostrea* with a large number of specimens of *Congeria* and many barnacles. The other mollusks are not so plentiful as in lot 1, there are no corals or corallines, but it is evident from the impressions on the shells that the oysters grew on mangroves or similar plants. The species will be considered in another paper along with those of the preceding collection.

3. *Fossils from the Gatun beds in the excavation of the Lower Locks at Gatun.* This bed was the source of most or all of the material described in our former paper.[2] A number of additional species

[1] Acknowledgments are due to Mr. D. F. MacDonald, geologist of the Canal Commission, who collected a large part of the material and supplied the data concerning it.

[2] Fauna of the Gatun Formation, Isthmus of Panama, *Proc. A. N. S. Phila.*, 1911, p. 336.

are here added. In this bed, especially in the part below sea level, the fossils are beautifully preserved, and the fauna, if it ever becomes completely known, will doubtless prove to be a very rich one. We have already discussed its position in the series in the paper noted above. The new species found in this lot are as follows (including 3 species of *Natica* collected by Brown, 1910):

Volvula micratracta n. sp.
Ringicula hypograpta n. sp.
Pleurotoma (*Gemmula*) *vaningeni* n. sp.
Drillia enneacyma n. sp.
Glyphostoma dentiferum Gabb.
Fasciolaria gorgasiana n. sp.
Turbonilla bartschiana n. sp.
Turbonilla gatunensis n. sp.
Natica bolus n. sp.
Natica canalizonalis n. sp.
Natica canrena (Linn.).
Sigaretus (*Eunaticina*) *gabbi* n. sp.
Pecten (*Cyclopecten*) *oligolepis* n. sp.
Corbula (*Cuneocorbula*) *hexacyma* n. sp.
Echinochama antiquata Dall.

4. *Fossils from the excavation of the Spillway, Gatun Dam.* This is in the Gatun Formation, here a rather soft, somewhat lignitic material, largely composed of volcanic ash. Besides the species noted below, it contains fragments of wood, nuts, and other remains of land plants, converted to lignite coal. The list of species observed in this Spillway material is as follows:

Conus concavitectum B. and P.
Cypræa henikeni Sowb.
Turritella altilira Conrad.
Pecten (*Amusium*) *luna* n. sp.
Pecten (*Euvola*) *reliquus* n. sp.
Cardium (*Trachycardium*) *dominicense* Gabb.
Cardium durum n. sp.
Tellina æquiterminata n. sp.
Dosinia delicatissima n. sp.
Clementia dariena (Conrad).
Petricola millestriata n. sp.
Thracia (*Cyathodonta*) *isthmica* n. sp.
Solen near *amphistemma* Dall.

5. *Fossils from the Cuts along the Relocation of the Panama Railroad in the Quebrancha Hills, nearly one mile south of Gatun.* This is in the Gatun Formation, and Mr. MacDonald notes that these

beds appear to be higher in the formation than those at the Spillway excavation. The fossils are pelecypods mostly and are similar to those in the upper part of the excavations for the Locks at Gatun as well as those from the Spillway. The material in which the shells are imbedded is mostly volcanic ash, often hardened by the calcium carbonate from the shells, which in their turn are partly dissolved and softened, falling out of the rock as casts of the interior of the shell and leaving a more or less perfect mould. The species identified are as follows:

Turritella altilira Conrad.
Turritella gatunensis Conrad.
Arca dariensis B. and P.
Cardium stiriatum B. and P.
Cardium dominicense Dall.
Chione tegulum B. and P.
Chione ulocyma Dall.
Callocardia gatunensis multifilosa Dall.
Clementia dariena (Conrad).
Cyclinella gatunensis Dall.

6. *Fossils from the fossiliferous layers near Tower N, Las Cascades, Culebra Cut.* At Las Cascades the Culebra Cut passes through a hardened volcanic ash or tuff, interbedded with which are several thin, fossil-bearing layers. The uppermost of these is some 85 feet above the bottom of the cut, as it was at the time this collection was made. It is a thin limestone bed, often not more than a few inches thick. This we have called the Pecten bed, from the numbers of *Pecten* and *Amusium* which it contains. This Pecten bed was seen by Professor Scott to extend along the cut to about a mile south of Empire, or at least two miles along the cut. The material of the bed is largely ash which is cemented to a firm stone by the calcium carbonate derived from the shells, which in many cases are dissolved, leaving a mould or cast. The list of species found in this Pecten bed includes several species found at the Spillway as well as at the Lock excavations at Gatun, along with several new species. The list of species identified from the Pecten bed is given below.

At 65 feet below the Pecten bed, and also at some 20 feet still lower, or what was the bottom of the cut when this collection was made, are black lignitic clays interbedded with the gray tuff which carry a fauna of small molluscan forms. These represent a dwarfed or "runt" fauna such as is often found in connection with lignitic formations. There are also remains of crustacea,

crabs, in the lower layer. It was in these lignitic layers that the oxidation of pyrite produced a heating of the shale, resulting in the generation of steam and gas that was reported in the daily press as the breaking out of a volcano in the Culebra Cut. The fossils are largely pseudomorphs of calcite, and when they are wetted the shell crumbles and falls apart. It is very difficult to clean the shells in this bed from the adhering shale on this account. The number of species is considerable, but only a few can be extracted in sufficiently clean condition to be determined or described. A list of the species that could be studied is given below:

SPECIES OBSERVED IN THE PECTEN BED AT TOWER N, LAS CASCADES.

Balanus sp.
Murex (*Phyllonotus*) *gatunensis* B. and P.
Pyrula micronematica n. sp.
Arca sp.
Pecten (*Amusium*) *sol* n. sp.
Pecten (*Amusium*) sp. indet. A fragment of an Amusium with even ribs.
Pecten (*Æquipecten*) *oxygonum canalis* n. subsp.
Ostrea gatunensis B. and P.
Tellina vetula n. sp.
Semele chipolana Dall.
Chione (*Lirophora*) *ulocyma* (Dall.).
Dosinia delicatissima n. sp.
Crassitellites mediamericanus n. sp.
Kuphus incrassatus Gabb.
Schizaster schertzeri Gabb.

SPECIES OBSERVED IN THE LIGNITIC LAYERS NEAR TOWER N, LAS CASCADES.

Callianassa scotti n. sp.
Nassa (*Hima*) *præambigua* n. sp.
Bittium scotti n. sp.
Turritella altilira Conrad.
Arca dalli n. sp.
Spondylus scotti n. sp.

DESCRIPTIONS OF NEW SPECIES.

Callianassa scotti n. sp. Pl. XXII, figs. 1-3.

The propodite is quadrate, its width nearly or quite equal to the length, the upper face evenly convex, its surface granular, at least near the base of the fixed finger. The proximal margin is abruptly

depressed. Lateral margin on the side of the fixed finger is acute and crenulated, the opposite edge being less acute and apparently smooth. The palm is convex in the middle, a little concave towards the crenulated margin. There is a submedian row of three small tubercles on the distal half. The fixed finger is quite slender and shorter than the palm.

Measurements (in Millimeters).

	Length exclusive of fingers.	Width in the middle.	Thickness.
a.	29	27	12
b.	24	21	10.3
c.	22	19	9.5

About 65 feet below the base of the Pecten bed at Tower N, Culebra Cut.

This species, one of the largest Callianassas, is rather abundant, represented in the collection by ten chelæ and some fragments. Named in honor of Professor William B. Scott. It is evidently what Herr Toula figured as *Krabbenscheren, l.c.*, p. 512, Taf. XXX, fig. 14.

In a few specimens the hand is longer, length of palm 30, width 24 mm.

In the Gabb collection from Costa Rica there is an imperfect hand evidently referable to the same species.

Volvulella micratracta n. sp. Text fig. 1.

Bulla (*Volvula*) *cf. oxytata* Bush, Toula, *l.c.*, p. 709, pl. 28, fig. 4, 1909.

The shell resembles *V. minuta* Bush, from which it differs by the noticeably longer posterior spine-like extension and more swollen shape. The spiral sculpture is decidedly stronger, consisting of distinct, continuous, widely spaced grooves, of which three are at the anterior and two at the posterior end. On the convex portion there is some appearance of very shallow longitudinal plication. There is a narrow umbilical slit.

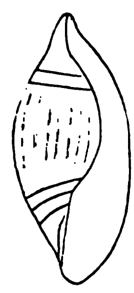

Fig. 1.

Length 1.5, diam. 0.7 mm.

The type from Gatun is probably conspecific with a series of five specimens from Monkey River, British Honduras. These are larger, up to 2 mm. long, and have more of the distinct grooves at the ends. They were found in mud brought up on an anchor.

V. oxytata is a much more cylindrical species.

Ringicula hypograpta n. sp. Text fig. 2.

Shell globose-conic, solid, composed of four moderately convex whorls. Apex obtuse. Surface smooth above, minutely engraved spirally below the periphery with about 10 lines; growth-lines visible but weak. The last whorl terminates in a thick and strong, rounded lip-varix. Outer lip is thickest in the middle, where it bulges forward and inward. Columella has a strong upper and thinner basal lamella. Parietal callus thick, provided with a small median fold.

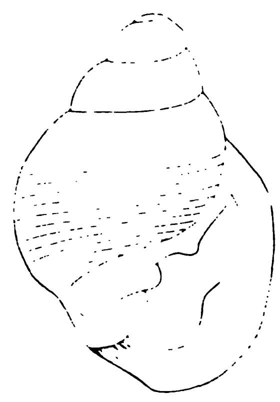

Fig. 2.

Length 2.1, diam. 1.5 mm.

Gatun bed, Lower Locks at Gatun.

Pleurotoma (Gemmula) vaningeni n. sp. Pl. XXII, fig. 4.

The shell is composed of about 13 whorls, of which the first $2\frac{1}{2}$ are smooth and convex; next whorl also convex, with sculpture of close, regular, axial ribs. At the beginning of the following whorl the sculpture changes abruptly. A strong, rounded cord appears immediately below the suture, and a stronger, wider one occupies the middle of the exposed part of the whorl, its summit bearing tubercles which are noticeably longer in the axial direction. On the last three whorls there are several spiral threads in the sulci above and below the median tuberculate ridge, and the tubercles upon the latter become somewhat more compressed. The last whorl has about ten major spirals and numerous unequal spiral threads below the peripheral ridge, the upper three spirals larger than the lower ones. There are also on the last three or four whorls rather close-set, retractive axial threads above the beaded ridge.

Length 19.5, diam. 7.3 mm.

Excavation at Gatun Locks.

This handsome species is named for Dr. Gilbert Van Ingen, of the Princeton University Museum.

Drillia enneacyma n. sp. Text fig. 3.

The shell is small, fusiform, composed of about 8 whorls, the first three smooth, the rest having sculpture of strong, rounded, slightly protractive, smooth, axial ribs, about as wide as their intervals and nine on each whorl. On the last whorl the ribs stop rather abruptly where the convex portion of the whorl passes into the short, tapering

anterior end, which has sculpture of spiral cords only. The intervals between ribs are crossed by low spiral cords separated by narrower grooves, which extend part way up the slopes of the ribs, but are wholly absent near and at their summits. On the last whorl about 9 spirals may be counted in each intercostal interval. The aperture is narrow, with a distinct but not deep posterior sinus.


Fig. 3.

Length 6, diam. 2.1 mm.

From excavation of the lower locks at Gatun.

Fasciolaria gorgasiana n. sp. Pl. XXII, fig. 5.

This species is represented by the last two whorls minus the anterior canal. A fusiform shell with the anterior extension quite narrow is indicated. The surface slopes rather steeply from the suture to the subangular shoulder and is ornamented on the last whorl with about 10 low, unequal spiral cords. The shoulder bears conic tubercles, a little compressed vertically, about 8 tubercles on each whorl. A cord at the shoulder and two others below it override tubercles and intervals, but are stronger on the tubercles. Below the shoulder the whorl is at first convex and sculptured with strong alternating with weak cords, then becomes concave, passing into the anterior canal. The columella has a group of three strong plaits. The diameter of the last whorl is about 21 mm.

Gatun bed.

This small species is related to the much larger *F. intermedia* Sowb. of the Santo Domingo Oligocene, but on comparison with a good series of that species it is seen that the coronal tubercles of *F. gorgasiana* are more acutely conic and radiate more horizontally; the last whorl also contracts more rapidly downwards. *Fusus quinquespinus* Dall has much resemblance to this species, but there are only five spines on the last whorl. The type is fragmentary, but so characteristic that there can be no difficulty in recognizing it. Named in recognition of the services to the State of Col. William C. Gorgas.

Nassa (Hima) præambigua n. sp. Pl. XXII, figs. 6, 7.

The shell resembles *N. ambigua* Mont., being acutely ovate-conic, the outlines of the spire straight, suture narrowly impressed, whorls not conspicuously convex except the last, which is rather ventricose. The apex is acute, first 2½ whorls smooth, subsequent

whorls with sculpture of rounded axial ribs nearly as wide as their intervals, crossed by spiral cords. On the last whorl there are 13 or 14 ribs, the last one larger, forming the lip-varix. The ribs are continuous from whorl to whorl as in some related forms. Spiral sculpture of low cords which are more prominent on the ribs, weak in the intervals, and to the number of eight on the last whorl above the basal sulcus. On the penultimate whorl there are three of these cords, lower than those on the last whorl, or sometimes 4 when the upper one is split. The aperture is small, apparently not unlike that of *N. ambigua*, but filled with coarse material in all the specimens.

Length 5.3, diam. 3.3 mm.

From a lignitic clay below the Pecten bed at Tower N, Culebra Cut. The specimens were taken from 65 to 80 feet below the Pecten bed. It is rather abundant.

In *Nassa ambigua* there are more spiral cords than in this species, and they are stronger in the intercostal intervals; the whorls of the spire are more convex. In *N. præambigua* the spire is straight-sided as in *N. vibex* Say. *N. bidentata* Emmons has fewer spirals and wider, fewer axial ribs. The recent *Alectrion* (*Hima*) *catallus* Dall, from deep water in the Gulf of Panama, is a more elaborately sculptured shell of the same group. *N. præambigua* is probably an ancestor of the Pliocene and recent members of the *Hima* group on both sides of the isthmus.

Pyrula micronematica n. sp. Pl. XXII, fig. 8.

The shell has the usual shape. Sculpture of small, slender spiral cords which are noticeably knotted where the rather wide-spaced axial threads intersect them. Minute secondary spiral threads divide the wide spaces of the primary cords. Faint traces of most minute spiral threads of a third order may be perceived. The spacing and number of spirals is the same as in the recent *P. decussata* Wood.

Length of the imperfect specimen figured 28.8 mm.

Found in the Pecten bed in the Culebra Cut near Tower N, Las Cascades.

This species agrees with *Pyrula decussata* Wood of the recent Panamic fauna in having only half as many major spirals as the Antillean *P. papyracea* Say and *P. pilsbryi* B. Smith. The essential differences between the two collateral phyla (represented in the recent fauna by *P. papyracea* and *P. decussata*), were therefore

well established in the Oligocene. *P. micronematica* is a much smaller species than *P. decussata* (of which it is probably an ancestor), with smaller, very slender primary spirals. In young *P. decussata* the spirals are much larger and closer together. Both of the specimens found are in the hard tufaceous rock of the Pecten bed. Neither shows the early or embryonic whorls.

Natica bólus n. sp. Pl. XXII, fig. 9.

The shell is rotund, solid, composed of 4½ whorls, the earlier ones slowly, the last two rapidly enlarging. The spire is very low, conic, narrow, and small, suture but little impressed; last whorl is a little depressed below the suture and smooth throughout. The aperture is semicircular as usual. The parietal margin is heavily calloused, chiefly in the upper angle, a short rounded ridge emerging just below it. A larger bluntly triangular lobe projects at the upper edge of the umbilicus, and a less conspicuous pad terminates a cord spirally entering the umbilical cavity.

Alt. 9, diam. 9.5 mm.

Gatun bed A. P. B., 1910.

This species differs from *N. canrena* by its much less deeply impressed suture, absence of tangential plication above, and various details of the columellar region.

Natica canrena (Linn.).

Several specimens, the largest having a diameter of 28 mm., were taken by one of us in the Gatun bed. They belong apparently to an early race of the *N. canrena* stock, such as that occurring in the Bowden bed. No opercula were obtained.

Natica canalizonalis n. sp. Pl. XXII, fig. 10.

The shell is hemispherical with a very small low-conic, subacute spire of 4½ whorls, the last two rapidly enlarging, last whorl somewhat depressed below the suture, which is very little impressed. The inner lip is very heavily calloused posteriorly, the part above the umbilicus very short, emerging a little, projecting at the upper margin of the umbilicus, the face of the projection transversely dented. The umbilicus is ample, rendered lunate by a flat median callus which terminates a cord spirally entering the umbilicus.

Alt. 8, diam. 8.3 mm.

Gatun bed, A. P. B., 1910.

The ample umbilicus, heavy, transversely dented parietal callus and appressed suture characterize this species, of which only one specimen was taken.

Sigaretus (Eunaticina) gabbi n. sp. Pl. XXII, fig. 13.

The shell is narrowly umbilicate, semiglobose, with very short, narrow spire of 3½ whorls. The first two whorls, which compose the embryonic shell, are convex, smooth, and glossy and increase slowly. After that the shell abruptly becomes dull, with sculpture of close, fine, spiral striæ. The last whorl is most convex below the periphery. The aperture is nearly as long as the shell, ovate. Columella somewhat thickened and a little rolled back.

Greatest length 6.5, diam. 6.5 mm.; length of aperture 6 mm.

Gatun Locks.

S. multilineatus Gabb from Sapote, Costa Rica, is a larger shell with more conic, elevated spire.

Bittium scotti n. sp. Pl. XXII, figs. 11, 12.

Shell turreted, with very slightly convex outlines, tapering to a minute, acute apex. Whorls about 12, the first 2 or 3 smooth. Subsequent whorls have sculpture of axial ribs about equal to their intervals, crossed by numerous unequal spiral threads. On the penultimate whorl there are about 15 axial ribs crossed by about 6 spiral threads and some minute striæ. On the last whorl there are one or two rounded varices, broader and more prominent than the ribs, which are very weak in their vicinity, and do not extend below the periphery. The base has 4 or 5 strong, continuous spiral cords.

Length	10.5,	diam.	3.8 mm.
"	9.5	"	3.6 "
"	8.5	"	2.8 "

About 65 to 80 feet below the Pecten bed at Tower N, Culebra Cut, near Las Cascades.

This shell stands close to *Bittium boiplex* Dall, of the Chipola Oligocene, which differs chiefly by its more slender contour. *B. priscum* Dall, of the Tampa Silex bed, seems to be an allied form with fewer spirals. *B. Scotti* is extremely abundant in the friable ignitic bed at Tower N, Culebra Cut, but most of the specimens are calcite pseudomorphs and cannot be extricated from the similar material in which they are imbedded.

Turbonilla (Chemnitzia) bartschiana n. sp. Text fig. 4a.

The shell is minute, slender, with a bulimoid embryonic shell of about 2 smooth whorls, the last strongly convex and nearly half immersed in the first neanic whorl; post-embryonic whorls 6, convex, with sculpture of smooth, rounded, vertical, axial ribs equal to their intervals. On the penultimate whorl there are 17 ribs.

On the last half of the last whorl the ribs become smaller; the concave intervals do not extend below the periphery and are rounded at their lower ends.

Length 2, diam. 0.6 mm.

Excavation at Gatun Locks.

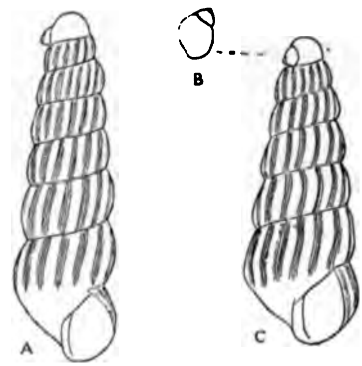

Fig. 4.

Turbonilla (Chemnitzia) gatunensis n. sp. Text fig. 4*b*, *c*.

The shell is minute, rather rapidly tapering, the diameter at the last whorl about double that of the first post-embryonic whorl. Embryonic shell bulimoid, of about 2 whorls, the last very globose, nearly half immersed. Post-embryonic whorls 5½, convex, the greatest convexity just above the suture, which is deeply impressed. Sculpture of rounded, slightly protractive, axial ribs, equal to their intervals, 14 on the last whorl; the concave intervals gradually effaced at the periphery of the last whorl.

Length 1.7, diam. 0.65 mm. Length of embryonic shell 0.3, diam. 0.2 mm.

Excavation at Gatun Locks.

Related to *T. bartschiana*, but more rapidly tapering, with the whorls more swollen below and the riblets noticeably protractive.

Arca dalli n. sp. Pl. XXIII, fig. 4.

A small, very obese ark, with beaks at the anterior fourth of the length, full and well incurved; hinge-line rather short. Valves equal, similarly sculptured with about 28 ribs wider than their intervals, those of the median and anterior part strongly and closely tuberculate, as in *Arca chiriquiensis* Gabb, the posterior ribs nearly smooth. Interior unknown.

Length 20, alt. 16, diam. 15.7 mm.

From a lignitic clay at the bottom of the Culebra Cut, near Tower N; a bed below the Pecten bed at the same place.

Pecten (Euvola) reliquus n. sp. Pl. XXIV, fig. 3.

"*Pecten sp.* (*vielleicht n. sp.*)" Toula, Jahrb. k.k. Geol. Reichsanst., 1908, LVIII, p. 755, text figs, 12, 13.

The left valve is strongly convex, the right almost flat, being very gently convex towards the beaks, concave on each side of the middle. Sculpture of about 24 strong ribs. In the left valve they

are a little flattened on the summits, have very steeply sloping sides, and are parted by intervals decidedly narrower than the ribs. Over all there is a fine concentric sculpture of delicate laminæ, which remain much more prominent in the intercostal spaces. In the right valve the ribs are noticeably narrower, about equal to their intervals, and they are almost obsolete in a rather wide band at the anterior end. The anterior ear is ribless. The concentric sculpture is less developed than in the convex valve. The height is 52 mm. in the largest co-type—a right valve.

Gatun Formation at the Spillway.

This scallop may be readily recognized, even in fragments, by its finer sculpture, which is unlike other Isthmian species.

Pecten oxygonum canalis n. subsp. Pl. XXIII, fig. 3.

We refer to this subspecies a series of scallops from the Pecten bed at Tower N, Culebra Cut, Canal Zone, which agree with the Costa Rican *P. o. optimum* in the main, but differ by having the radial striæ almost equal, without an enlarged one on the ridge of each rib. The number of ribs is the same as in *optimum*. The figured specimen measures, alt. 45.5, length 44 mm. Some are larger, up to 55 mm. in length.

This is a very abundant and characteristic fossil of the upper bed of hard limestone near Tower N. The shells cannot be extricated from the rock, in which they are exposed by breaking it up. While this *Pecten* is obviously close to Costa Rican and Haitian forms, it seems advisable to signalize the minor differences of the races by subspecific names.

Pecten oxygonum optimum n. subsp. Pl. XXIII, fig. 2.

Pecten paranensis d'Orb., Gabb, Journ. A. N. S. Phila., VIII, p. 347, pl. 45, fig. 24. Not of d'Orbigny, Voyage dans l'Amér. Mérid., Palæontologie, p. 132.

The shell is larger than *P. oxygonum* Sowb., of the Santo Domingo Oligocene, with lower ribs. There are at least 19 ribs, several at each end, narrow, low, and slender, the rest rounded, broad, and rather low, parted by somewhat narrower intervals. Both ribs and intervals bear unequal radial striæ or threads, of which one on the summit of each rib is somewhat larger, giving the ribs a carinated appearance. There is also an enlarged thread in the middle of some of the intercostal valleys. About 11 striæ may be counted between the summit of one rib and the next. Auricles strongly striated radially. The whole surface (except near the beaks) bears

a dense and minute sculpture of raised concentric threads or growth-laminæ, which are not emphasized in passing over the striæ.

Length 62, altitude 57, semidiameter 13 mm.

Reventazon River, Costa Rica. Type a right valve. Collected by Wm. M. Gabb, Coll. A. N. S. P.

This specimen was referred by Gabb to *P. paranensis* Orb., which, while doubtless related, differs decidedly in the secondary sculpture. We are equally unable to refer the Costa Rican species to *P. madisonius*, which has higher and usually fewer ribs. The Santo Domingan specimens which Gabb identified as the unfigured *P. oxygonum* Sowb. are all smaller than the present shell, with somewhat more elevated ribs, which bear fewer radial striæ.

Dall has proposed a *Pecten gabbi*[3] for specimens from Antigua and Santo Domingo, which have the general form of this shell, but differ by having "narrower interspaces each filled with one imbricated riblet." In *P. optimum* there are 4 or 5 striæ in each interval, and when one is larger it is not conspicuously so. Dall includes Gabb's Costa Rican shell in his references, but does not refer to it in the text. Gabb does not report *paranensis* from Santo Domingo.

Pecten (Cyclopecten) oligolepis n. sp. Text fig. 5.

Pecten app. *subhyalinus* *Smith*, Toula, J. B. der k.k. Geolog. Reichsanstalt, 1911, Bd. 61, p. 492, pl. 31, figs. 1*a*, *b*, *c*.

This shell is very close to the West Indian *Cyclopecten simplex* Verrill, but differs in details of sculpture. The right valve has concentric sculpture of excessively faint and fine striæ, scarcely visible, and only under the compound microscope, and there are slightly more distinct radial threads near the edges. The left valve has rather widely spaced low concentric threads and more delicate radial threads, chiefly seen near the margins. In *C. simplex* the right valve is the more strongly sculptured, according to Verrill. The internal structure is substantially as figured for *C. simplex* (*Trans. Conn. Acad.*, X, pl. 19, figs, 1, 2).

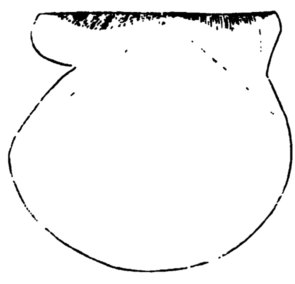

Fig. 5.

Length 2.8, height 2.7, diam of right valve .8 mm.

From the excavation of the lower locks at Gatun.

[3] *Trans. Wagner Free Inst. Sci.*, III, p. 717, pl. 29, fig. 3.

Pecten subhyalinus E. A. Smith, from the west coast of Patagonia, is somewhat higher than long, the hinge line is shorter and the valves somewhat less convex than in *P. oligolepis*.

Pecten (Amusium) sol n. sp. Pl. XXIV, figs. 1, 2.

The shell is subcircular, thin, but slightly convex, nearly smooth (the growth-lines being very faint) except near the beaks, where there are radial riblets, low, rounded, but very distinct for a distance of about 10–14 mm., then gradually becoming weak and disappearing. In the left valve the beak is depressed, almost flat, and the auricles are marked off by a small ledge, but no decided change in the general curvature of the surface. In the right valve the beak is somewhat convex and separated from the more distinctly demarked auricles by a groove. Internally the shell has radial ribs in pairs, the interval between the ribs of a pair being about one-third the width of the interval between pairs.

Two valves, cotypes, measure 83 mm. from beaks to basal margin. Some specimens represented by internal casts are larger, up to 90 mm. in altitude in the case of a large one. This valve measured 90 mm. in length.

From a bed with *Pecten oxygonum optimum* in the Culebra Cut, near Tower N, Las Cascades.

This species and *Pecten oxygonum optimum* are characteristic fossils of what we have called the Pecten bed, at Tower N.

This *Amusium* differs from *Pecten toulæ*, of the Gatun bed, *P. papyracea* Gabb, of Santo Domingo, and the North American *P. mortoni* by having strong radial sculpture in the early neanic stage; those species agreeing with the recent Oriental forms in having no external radial sculpture at any stage. *P. lyonii* Gabb, described from Sapote, Costa Rica, agrees with *P. sol* in having radial beak sculpture, but it differs by having more distinctly defined auricles and by the internal sculpture of numerous equidistant ribs. While the ribs of one valve are not perceptibly twinned in the Oriental Amusiums, they are about equal in number in the two valves in *P. pleuronectes* L., in which this character of having one valve with equally spaced ribs and one with paired ribs is very pronounced. With the single exception noted below, all of the casts we have seen from the Pecten bed agree in having ribs in contiguous pairs.

In one incomplete cast the ribs are in pairs separated by intervals fully half as wide as the spaces between pairs (not crowded as in *P. lyonii* Gabb). This probably represents another species.

Pecten (Amusium) luna n. sp. Pl. XXIII, fig. 1.

A species resembling *P. mortoni* Conr., from which it differs chiefly by the ears which are depressed below the plane of the valve and separated by a ledge. In *P. mortoni* the ears are nearly level with the adjacent part of the valve, from which grooves separate them. The hinge-line is short, not serrate above in the right valve, as in *P. mortoni*. The surface is smooth throughout except for the usual fine growth-lines and fine, indistinct radial striation, such as is seen in *P. mortoni*. The laterodorsal lines diverge more than in *mortoni,* forming a greater angle at the beak. The internal ribs run in pairs, spaced about as in *P. sol*. The shell is rather strongly convex for an *Amusium,* more convex than in *P. mortoni*.

Alt. 76, length 80 mm.; diam. right valve 12 mm.

Gatun Formation at the Spillway.

The type is a right valve, which we at first referred to *P. sol,* from which it differs chiefly by the unsculptured beak and the ledges defining the ears.

P. toulæ differs by its gray radii.

Spondylus scotti n. sp. Pl. XXV, figs. 1, 2.

A species of the *S. americanus* group, having the lower valve very convex, the upper valve moderately so; beak not much produced. Sculpture of about 17 narrow little-prominent radial ribs, some of them bearing very short, scale-like spines, irregularly placed, and on the lower half only; between these ribs there are fine, unequal longitudinal striæ, 4 to 8 in each space. They are crenulated by extremely fine, crowded laminæ along the growth-lines. There are some weakly developed foliations on one side of the lower valve.

Breadth 51 mm., length (alt.) of lower valve 65, of upper 58 mm., diam. 41 mm.

From the lignitic bed below the Pecten bed at Tower N, Culebra Cut.

Well distinguished from the recent Antillean *S. americanus* Hermann by the delicacy of the sculpture and more convex lower valve. It is also somewhat related to *S. gumanomocon*[4] of the

[4] *Spondylus gumanomocon* n. sp. A species resembling *S. varians* Sowb. (*S. delessertii* Chenu). The upper valve is Pectiniform, orbicular, of moderate thickness, with low radial ribs, the principal ones irregularly spinose, spines short; cardinal area small and short, as in *S. americanus*. Lower valve very ponderous, with a long, level (not receding) cardinal area, and a very long, straight (or sometimes laterally curved) beak, the cavity of which is deeply excavated in young shells, nearly solidly filled in old ones. Sculpture like the upper valve, except that it is more or less extensively foliated towards the beak.
Length (alt.) of a lower valve 175 mm.; breadth 108 mm.; weight 32½ oz.
Santo Domingan Oligocene. This is the form identified by Gabb as *Spondylus americanus*.

Santo Domingo Oligocene, but that is a far more ponderous and long-beaked species.

Crassatellites reevei Gabb. Pl. XXIII, fig. 5.

Crassatella antillarum Reeve? = *C. reevei* Gabb, Topography and Geology of Santo Domingo, p. 252.

The shell is rather long, length over $1\frac{1}{2}$ times the alt., anterior end rounded, posterior end long, tapering, obliquely truncate at the end. Beaks at the anterior third of the length. Ridge from beak to post-basal angle is moderately prominent, broad and rounded, and with the posterior slope above it has sculpture of growth-lines only. A distinct angulation runs from beak to the upper posterior angle. The escutcheon is moderately deep and flat, defined by a ridge. A broad, shallow concavity terminating in a sinuation of the basal margin precedes the post-basal ridge. The rest of the surface is convex, closely, almost regularly costate concentrically, the riblets about equal to their deep intervals. This sculpture extends without irregularity upon the beak, which is rather flattened.

Length 56, alt. about 37, semidiameter 11 mm.

This specimen was first identified by Gabb as perhaps *C. antillarum* Reeve, a recent species differing conspicuously in sculpture and shape. No description has been published hitherto, Gabb's notes being quite insufficient for identification.

The type, Coll., A. N. S. P., is a right valve, collected by Gabb in Santo Domingo.

Crassatellites mediamericanus n. sp. Pl. XXV, figs. 3-5.

Crassatella mactropsis Con., Gabb, Journ. Acad. Nat. Sci. Phila., VIII, p. 345, pl. 44, fig. 20. Not *Grateloupia mactropsis* Conrad.

The shell closely resembles *C. reevei* Gabb, from which it differs in the following particulars. The posterior end is broader, tapering much less; the terminal truncation is less oblique; no angulation runs to the upper posterior angle of the valve. Finally, there are a couple of concentric waves of much greater amplitude defining the umbonal area, which bears about 5 small waves. In *C. reevei* there is no such irregularity in the sculpture.

Length about 53, alt. 41, diameter .25 mm.

Sapote, Costa Rica, in a bed considered Miocene by Gabb. Cotypes Coll., A. N. S. P.

Two imperfect individuals from Gabb's collection are figured, pl. XXV, figs. 3, 4. We refer also to this species a shell, pl. XXV, fig. 5, imbedded in hard matrix from the Pecten bed at Tower N, Culebra Cut.

So far as exposed, this fossil resembles the Costa Rican form, but its condition does not admit a positive identification. As this form is intimately related to *C. reevei* Gabb, of Santo Domingo, we subjoin some account of that species.

Cardium (Trachycardium) durum n. sp. Pl. XXIII, fig. 6.

This species is represented by a cast of the right valve with the inner layers of shell adhering. It is strongly convex with prominent, very full beaks. Twenty-five strong, angular ribs are indicated, those of the posterior margin terminate in teeth. There is some indication that the ribs had lateral ridges. The posterior slope shows a wide, shallow radial concavity.

Length 39, alt. 41.5, semidiam. 19 mm.

Gatun Formation at the Spillway.

This is a longer shell than *C. stiriatum* B. and P., the valve-margins being not far from circular, while in *C. stiriatum* the outline is conspicuously oblong.

Dosinia delicatissima n. sp. Pl. XXVI, fig. 1.

Dosinia (*Artemis*) *cf. Acetabulum* Conr., Toula, l.c., p. 727, pl. 27, figs. 8, 8*a*.

Specimens from the Spillway agree well with Dall's account and figures of *D. liogona* Dall (*Trans. Wagner Inst.*, III, p. 1230, pl. 53, figs. 4, 7; pl. 54, fig. 11), except that the shell is remarkably thin for a bivalve of this genus. A valve at least 60 mm. in length is only 1.3 mm. thick in the thickest part. Moreover, the sculpture does not rise in "sharp fine lamellæ towards the ends of the shell," as described for that species. Towards the ends of the shell the concentric ridges between the grooves are more raised than in the middle of the valves, but they are rather too thick and blunt to be called lamellæ. The specimens are all in poor condition so that the sculpture of the beaks is a little in doubt, but from a small area exposed in one specimen the very young shell would appear to be smooth.

Length 48, alt. 46, semidiameter about 11 mm. Less perfect specimens than that figured are larger, up to 55 to 60 mm., or even more.

Very plentiful in the Gatum Formation at the Spillway.

It occurs also in the Pecten bed at Tower N.

The Miocene *D. acetabulum* Conr. is a decidedly more solid shell, noticeably differing from *D. delicatissima* in sculpture.

Petricola millestriata n. sp. Pl. XXVI, fig. 2.

The shell is short, the height contained about $1\frac{1}{3}$ times in the length,

beaks at the anterior $\frac{4}{11}$ of the length, prominent; anterior end rounded, posterior end wider, rounded in its lower half, obliquely truncate above; basal margin evenly arcuate. The surface is marked with unequal and mostly inconspicuous concentric wrinkles and fine, close, radial threads, narrower than their intervals.

Length 27, alt. 21, semidiam. 7.5 mm.

Gatun Formation at the Spillway.

A short, Tapes-like species with fine but distinct sculpture. On the internal cast figured, the radial striæ are obsolete towards the two ends, but judging from an incomplete mould of the exterior, the striæ extend undiminished nearly to the anterior end. The interior is unknown. The shell was apparently quite thin.

Tellina æquiterminata n. sp. Pl. XXVI, fig. 5.

Known by a cast of the left valve, not differing much from *T. radiata* in outline, but rather wider posteriorly and not twisted. Beaks submedian; anterior end rather broadly rounded; posterior end more tapering, but well rounded distally. The cast retains vestiges of the external sculpture of concentric rather regular growth-wrinkles. A low ridge indicates an impressed pallial line. The capacious pallial sinus extends well beyond the beaks, and is apparently confluent with the pallial line below, its upper line being well arched.

Length 44.5, alt. 24, diam. of left valve 5.5 mm.

Gatun Formation at the Spillway.

Tellina (Eurytellina) vetula n. sp. Pl. XXVI, fig. 6.

This species, known only by mutilated and imperfect remains, is yet readily distinguishable by the sculpture of minute, crowded concentric threads, narrower than their intervals, and about 12 to 15 in the space of 5 mm. in the lower half of the valve.

There seems to be a rather emphatic radial sinuosity posteriorly; the basal margin is well arched and the form rather broad. The best-preserved example, which is imperfect anteriorly, has a length of 43, alt. 29 mm.

Pecten bed near Tower N, Culebra Cut.

Semele chipolana Dall.

Trans. Wagner Free Inst. Sci., III, p. 986, pl. 37, fig. 3.

Pecten bed near Tower N. A nearly perfect mould of the left valve, which agrees very well with Dall's account of this species in shape and sculpture. The ample pallial sinus extends past the middle of the valve.

In *S. sayi* Toula the concentric sculpture seems to be decidedly closer.

Thracia (Cyathodonta) gatunensis Toula. Pl. XXVI, fig. 3.

Thracia gatunensis Toula, Jahrb. k.k. Geol. Reichsanst., 1908, LVIII, p. 757; text fig. 15.

The shell resembles *Cyathodonta spenceri* Dall[5] in contour, except that it is apparently not quite so high. The right valve is rather strongly convex, with sculpture of concentric ripples which are as wide as their intervals or slightly wider. The ripples terminate on the rounded ridge which defines the nearly smooth posterior area of the valve. There is a minute irregularly granulose lineolation along growth-lines, over the wave sculpture.

Length 28.5, alt. 21, diam. of right valve about 8 mm.

Spillway, Gatun Dam.

While evidently akin to *T. spenceri* Dall, this species differs by its sculpture, the former having concentric ripples narrower than their intervals. The specimen figured is a right valve, the edge partly imperfect, and the interior concealed by the hard rock. Toula's specimen was larger, 52 mm. long, and the concentric ribs are closer near the beaks.

Corbula (Cuneocorbula) hexacyma n. sp. Pl. XXVI, fig. 4.

Known from the right valve only. The shell resembles *C. viminea* Guppy externally. The distinctly prosogyrate beaks are at the anterior third of the length, smooth at the tip, posterior end produced, terminating in a short, strongly oblique, straight truncation, the lower point projecting and acute, the basal margin is rather deeply sinuated near the posterior end, elsewhere strongly arcuate. Dorsal margin formed of two straight slopes meeting at an angle of about 130 degrees. The posterior adductor impression rests upon a thick raised ledge which extends obliquely across the posterior end of the interior. There is no lunule. Externally a rather strong keel runs from back to post-basal angle, and an inconspicuous angulation runs to the upper angle of the posterior truncation, defining a lanceolate depressed area. There are irregularly spaced fine growth-wrinkles above the keel. The rest of the valve has a sculpture of very fine, delicate radial threads, and 6 concentric waves, the upper two weak, the others very strong. The region of the beak has no concentric waves. A shell 7 mm. long would show radial striation only.

[5] *Trans. Wagner Free Institute of Science*, III, p. 1527, Oligocene of Guadaloupe.

Length of right valve 18.7, alt. 11, diameter 4.8 mm.

Gatun Formation, from the excavation at the lower locks at Gatun.

This species has much in common with such species of the subgenus *Bothrocorbula* as *C. viminea* Guppy and *C. radiatula* Dall, and *C. synarmostes* Dall, but the total absence of any trace of a lunular pit at once distinguishes the Gatun form. The small number of concentric waves of the exterior separates *C. hexacyma* from various species of *Cuneocorbula*, which otherwise resemble it more or less.

Explanation of Plates XXII–XXVI.

Plate XXII.—Figs. 1–3.—*Callianassa scotti* n. sp.
Fig. 4.—*Pleurotoma* (*Gemmula*) *vaningeni* n. sp. × 3.
Fig. 5.—*Fasciolaria gorgasiana* n. sp. × 3.
Figs. 6, 7.—*Nassa* (*Hima*) *præambigua* n. sp. × 4.
Fig. 8.—*Pyrula micronematica* n. sp. × 2.5.
Fig. 9.—*Natica bolus* n. sp. × 3.
Fig. 10.—*Natica canalizonalis* n. sp. × 3.5.
Figs. 11, 12.—*Bittium scotti* n. sp. × 3.5.
Fig. 13.—*Sigaretus Eunaticina*) *gabbi* n. sp. × 3.5.

Plate XXIII.—Fig. 1.—*Pecten* (*Amusium*) *luna* n. sp.
Fig. 2.—*Pecten oxygonum optimum* n. subsp. (Costa Rica).
Fig. 3.—*Pecten oxygonum canalis* n. subsp.
Fig. 4.—*Arca dalli* n. sp.
Fig. 5.—*Crassatellites reevei* Gabb.
Fig. 6.—*Cardium* (*Trachycardium*) *durum* n. sp.

Plate XXIV.—Figs. 1, 2.—*Pecten* (*Amusium*) *sol* n. sp.
Fig. 3.—*Pecten* (*Euvola*) *reliquus* n. sp. detail of sculpture.

Plate XXV.—Figs. 1, 2.—*Spondylus scotti* n. sp.
Figs. 3, 4.—*Crassatellites mediamericanus* n. sp. (Costa Rica).
Fig. 5.—*Crassatellites mediamericanus* n. sp. Pecten Bed, Las Cascades, C. Z.

Plate XXVI.—Fig. 1.—*Dosinia delicatissima* n. sp.
Fig. 2.—*Petricola millestriata* n. sp.
Fig. 3.—*Thracia* (*Cyathodonta*) *gatunensis* Toula.
Fig. 4.—*Corbula* (*Cuneocorbula*) *hexacyma* n. sp.
Fig. 5.—*Tellina æquiterminata* n. sp.
Fig. 6.—*Tellina* (*Eurytellina*) *vetula* n. sp.

FURTHER NOTES ON THE FLORA OF THE CONOWINGO OR SERPENTINE BARRENS OF SOUTHEASTERN PENNSYLVANIA.

BY FRANCIS W. PENNELL.

Two years ago the writer published in the PROCEEDINGS OF THE ACADEMY OF NATURAL SCIENCES[1] an account of the flora of the Conowingo or Serpentine Barrens of southeastern Pennsylvania. Effort was made, by field collections and herbarium-study, to form a reasonably complete list of the characteristic species. At that time, however, he had been unable to make full collections during June, and collections made at this season during 1911 and 1912 have shown a considerable number of omissions. As collections have now been made during every month of the growing season, and it is believed a practically complete view of the flora gained, it has seemed advisable to thoroughly revise and emend the list previously offered.

In addition to his own and Bayard Long's collections of the past two seasons, he has had the opportunity of reviewing the valuable material of Albert Commons recently presented to the Academy. The Serpentine specimens in this collection are nearly all from Centerville, Newcastle County, Del. As this locality is now threatened with extinction, we are fortunate in possessing some record of its flora.

In the preparation of these notes he has been much indebted to Mr. Bayard Long, who throughout has given him most valuable assistance. He is also indebted to Mr. Eugene P. Bicknell for verification of certain determinations in *Agrostis* and *Carex*.

As some of the locality names used do not appear on the local maps, it may, though late, be of service to indicate by latitude and longitude the location of each barren. Each area may so be found either on the Philadelphia Geological Folio, where the Serpentine areas are indicated in green and labelled "sp," or on the Soil Survey of Chester County, where the more definite Conowingo Barrens are indicated in yellow and labelled "Cb."

[1] *Proc. Acad. Nat. Sci. Phila.* (October, 1910), pp. 541–584. Issued January 13, 1911.

CHESTER GROUP:

Delaware County—

1. Fawkes Run (Newtown)	75° 22′ 48″ W.	x 39° 59′ 40″ N.
2. Preston Run	75° 26′	x 39° 58′ 30″
3. Bear Hill	75° 23′ 20″	x 39° 57′
4. Blue Hill	75° 24′ 40″	x 39° 57′
5. Middletown Township—		
(*a*) Mineral Hill	75° 24′ 55″	x 39° 55′ 10″
(*b*) Barrens of Middletown	75° 25′ 45″	x 39° 55′ 45″
(*c*) Williamson	75° 25′ 40″	x 39° 54′ 30″
(*d*) Glen Riddle	75° 25′ 50″	x 39° 54′ 25″
(*e*) Lenni	75° 26′ 30″	x 39° 53′ 50″
(*f*) Wawa	75° 26′ 30″	x 39° 54′ 20″

Chester County—

6. Serpentine Ridge—		
(*a*) Paoli	75° 29′ W.	x 40° 1′ 40″ N.
(*b*) Sugartown Barrens	75° 30′	x 40° 1′
(*c*) Narrow extension from this, trending west-southwest to Goshenville, the Serpentine Ridge of records.		
7. Cedar Barrens (marked "Cs" on Soil Survey)	75° 29′ 15″ W.	x 39° 57′ 50″ N.
8. West Chester (Fern Hill)	75° 35′ 40″	x 39° 59′
9. (*a*) Sconnelltown (not labelled on Soil Survey	75° 37′ 30″	x 39° 56′ 7″
(*b*) Strode's Mill (not indicated on Soil Survey)	75° 37′ 8″	x 39° 55′ 40″
10. Brinton's Quarry (not labelled on Soil Survey)	75° 35′ 40″	x 39° 54′ 50″
11. Marshallton (not labelled on Soil Survey)	75° 40′	x 39° 59′
12. Unionville	75° 43′	x 39° 54′ 40″

Newcastle County—

13. Centerville

STATE-LINE GROUP:

14. Nottingham Barrens (Chester County)—		
(*a*) Nottingham	76° 1′ 30″ W.	x 39° 44′ 20″ N.
(*b*) Goat Hill	76° 5′	x 39° 43′ 30″
15. Other specimens, mainly collected by J. J. Carter, are cited from points in southern Lancaster County.		

The emendations of the list of component species require a few changes in the descriptive text:

Page 545, line 18—For *Aster parviceps pusillus* here and throughout read *Aster depauperatus*.

Page 545, line 5 from bottom—To list of constant grasses and sedges of park-like openings add: *Sphenopholis obtusata, Carex annectens, Carex scoparia, Carex normalis.*

Page 546, line 2 from bottom—To species of moist open depressions add: *Agrostis antecedens, Carex lanuginosa, Carex leersii, Carex incomperta, Carex interior,* and *Juncus dichotomus platyphyllus.* All but the first and last are quite local.

Page 547, line 24—To list of species found only on State-line Barrens add: *Carex leersii* Willd.

Page 547, line 8 from bottom — Strike out *Scutellaria parvula ambigua.*

Page 548, line 4—Strike out *Sphenopholis obtusata pubescens.*

Page 549, lines 6 and 12—For *Sphenopholis obtusata pubescens* read *Sphenopholis obtusata.*

Page 549, line 19—Read: and reported from adjacent West Virginia. As shown in discussion under *Aster depauperatus,* such distribution is quite improbable.

I. Emendations of the List of Species composing the Flora of the Conowingo Barrens.

Insert the following corrections and additions under their respective numbers, symbols and county names, Delaware and Chester, as in original list. Records from Newcastle County, Delaware, are added. As before, unless otherwise credited, all records are represented by specimens of the writer's collecting.

†1. Osmunda spectabilis. For L. read Willd.

†6. Pinus virginiana Mill. Add:
Chester.—Nottingham Barrens (B. Long).

†18. Panicum depauperatum Muhl. Add:
Delaware.—Mineral Hill, Williamson.
Newcastle.—Centerville.

†19. Panicum linearifolium Scribn. Read:
Local on dry barrens.
Delaware.—Fawkes Run.
Chester.—Nottingham Barrens.

23. Panicum huachucæ silvicola Hitchc. and Chase. Add:
Chester.—Paoli; Serpentine Ridge (B. Long).
— Nottingham Barrens.
Newcastle.—Centerville.

Insert:

†23A. PANICUM VILLOSISSIMUM Nash.

Occasional on dry barrens.

Delaware.—Preston Run; Williamson (B. Long).

Chester.—West Chester.

‡26. PANICUM BOSCII Poir.

This is *P. boscii molle* (Vasey) Hitchc. if the form can be distinguished. Add:

Delaware.—Preston Run.

†35. MUHLENBERGIA FOLIOSA Trin. Add:

Chester.—Nottingham Barrens (E. B. Bartram.)

†39. AGROSTIS ANTECEDENS Bicknell.[2] Read:

Frequent on moist to desiccated soil. This June-flowering plant appears quite distinct from the late-flowering *A. hyemalis* (Walt.) B. S. P., with which it has been confused. Its characteristics have been clearly pointed out by Mr. E. P. Bicknell, to whom I am indebted for confirmation of this determination.

Delaware.—Fawkes Run; Williamson.

Chester.—Serpentine Ridge; Cedar Barrens.

— Nottingham Barrens.

41. DANTHONIA SPICATA (L.) Beauv. Add:

Delaware.—Bear Hill.

Chester.—Paoli; Sugartown Barrens; Cedar Barrens; West Chester.

— Nottingham Barrens.

Insert:

†44A. SPHENOPHOLIS OBTUSATA (Michx.) Scribn.

Frequent on dry open barren. Normally more or less scabrous, at least on the lower sheaths.

Delaware.—Bear Hill.

Chester.—Serpentine Ridge; Cedar Barrens.

— Nottingham Barrens.

†45. SPHENOPHOLIS OBTUSATA PUBESCENS (Scribn. and Merr.) Scribn. Read:

[2] *Bull. Torr. Bot. Club*, XXXV (1908), 473.

Frequent on dry open barren. With the last, and intergrading with it.

Delaware.—Fawkes Run; Bear Hill; Williamson.

Chester.—Sugartown Barrens.

— Nottingham Barrens.

Insert:

45A. PANICULARIA NERVATA (Willd.) Kuntze.

Common in moist soil, Serpentine swamps.

Delaware.—Williamson.

Chester.—Paoli; Serpentine Ridge; Cedar Barrens.

— Nottingham Barrens.

*50. FIMBRISTYLIS LAXA Vahl. Add:

Newcastle.—Centerville (A. Commons).

†51. SCIRPUS ATROVIRENS Muhl. Add:

Chester.—Cedar Barrens; Unionville.

†54. SCLERIA PAUCIFLORA Muhl. Add:

Newcastle.—Centerville (A. Commons).

56. CAREX LURIDA Wahl. Read:

Common in Serpentine swamps.

Delaware.—Williamson.

Chester.—Paoli; Serpentine Ridge; Cedar Barrens; West Chester; Unionville.

— Nottingham Barrens.

†57. CAREX HYSTERICINA Muhl. Read:

Frequent or local in Serpentine swamps.

Delaware.—Williamson.

Chester.—Unionville.

— Nottingham Barrens.

Insert:

†57A. CAREX LANUGINOSA Michx.

Frequent in Serpentine swamps.

Delaware.—Williamson.

Chester.—Serpentine Ridge; West Chester.

Insert:

57B. Carex stricta Lam.

Frequent in Serpentine swamps.
Delaware.—Williamson.
Chester.—Cedar Barrens; West Chester.
— Nottingham Barrens.

58. Carex triceps hirsuta (Willd.) Bailey. Add:

Newcastle.—Centerville.

Insert:

58A. Carex triceps bushii (Mackenzie) Stone.[3]

Dry open barren, on State-line Barrens only.
Chester.—Nottingham Barrens.

†59. Carex glaucodea Tuckerm. Read:

Frequent on dry open barrens.
Delaware.—Mineral Hill; Williamson.
Chester.—Paoli; Serpentine Ridge; Cedar Barrens; West Chester; Unionville.
— Nottingham Barrens.
Lancaster.—New Texas (J. J. Carter).
Newcastle.—Centerville.

Insert:

59A. Carex umbellata abdita (Bicknell) Stone.[4]

Occasional on dry barrens, edges of woodland.
Chester.—Paoli; Marshallton (B. Long).

Insert:

59B. Carex willdenovii Schkuhr.

Dry rocky woodland.
Newcastle.—Centerville (A. Commons).

60. Carex vulpinoidea Michx. Read:

Frequent in moist soil.
Delaware.—Mineral Hill; Williamson.
Chester.—Paoli; Sugartown Barrens; Cedar Barrens; West Chester.

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[3] *Annual Report New Jersey State Museum* (1910), 299.
[4] *Annual Report New Jersey State Museum* (1910), 305.

Insert:

60A. CAREX ANNECTENS Bicknell.[5]

Frequent on dry open barrens.

Delaware.—Mineral Hill; Williamson; Wawa.

Chester.—Paoli; Sugartown Barrens; Serpentine Ridge; Ced. Barrens.

— Nottingham Barrens.

†61. CAREX RETROFLEXA Muhl. Read:

Local on moist depressions or grassy open.

Delaware.—Bear Hill; Mineral Hill.

Chester.—West Chester.

— Nottingham Barrens.

Insert:

†61A. CAREX LEERSII Willd.[6]

Moist soil along stream.

Chester.—Nottingham Barrens.

Insert:

†61B. CAREX INCOMPERTA Bicknell.[7]

Locally abundant in Serpentine swamps. Identification co firmed by Mr. E. P. Bicknell.

Delaware.—Williamson.

Chester.—West Chester.

Insert:

†61C. CAREX INTERIOR Bailey.

Locally abundant in Serpentine swamps.

Chester.—Cedar Barrens.

— Nottingham Barrens.

62. CAREX SCOPARIA Schkuhr. Read:

Common on dry barrens.

Delaware.—Mineral Hill; Williamson.

Chester.—Paoli; Sugartown Barrens; Serpentine Ridge; Cec Barrens; West Chester; Unionville.

— Nottingham Barrens.

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[5] *Bull. Torr. Bot. Club*, XXXV (1908), 492.

[6] Cf. Mackenzie, *Bull. Torr. Bot. Club*, XXXVII (1910), 245.

[7] *Bull. Torr. Bot. Club*, XXXV (1908), 494.

Insert:

62A. CAREX NORMALIS Mackenzie.[8]

Frequent or local on dry open barren.
Delaware.—Bear Hill; Mineral Hill; Williamson.
Chester.—Cedar Barrens; West Chester (B. Long).
— Nottingham Barrens.

Insert:

62B. CAREX HORMATHODES RICHII Fernald.

Moist soil along stream. It seems unnatural to consider this inland plant a variety of *Carex hormathodes*, characteristic of the salt marshes along the coast, but in the material at hand I cannot feel confident in separating them. *Richii* appears to differ in its smaller, broader perigynia, at maturity less prominently nerved, its achene relatively more turgid, dull, not glistening as in *hormathodes.*
Chester.— Serpentine Ridge.

*63. CAREX BICKNELLII Britton. Read:

Local on dry open barrens.
Delaware.—Bear Hill; Williamson; Glen Riddle.
Chester.—Cedar Barrens; West Chester; Brinton's Quarry.
Newcastle.— Centerville (A. Commons).

64. JUNCUS EFFUSUS L. Read:

Common in Serpentine swamps.
Delaware.—Williamson.
Chester.—Paoli; Cedar Barrens; West Chester.
— Nottingham Barrens.

‡65. JUNCUS TENUIS Willd. Add:

Delaware.—Mineral Hill.
Chester.—Paoli; Serpentine Ridge (B. Long).

†66. JUNCUS SECUNDUS Beauv. Add:

Newcastle.— Centerville (A. Commons).

Insert:

†66A. JUNCUS DICHOTOMUS PLATYPHYLLUS Wiegand.

[8] *Bull. Torr. Bot. Club*, XXXVII (1910), 244.

Frequent in moist soil. In a forthcoming paper Mr. Bayard Long and the writer hope to present evidence for considering this a distinct species. All discussion accordingly is deferred.

Delaware.—Williamson.

Chester.—Paoli; West Chester; Unionville.

— Nottingham Barrens.

70. JUNCOIDES CAMPESTRE (L.) Kuntze. Read:

Frequent on edge of greenbrier or woodland. Plant habitually tufted, a number of stems from one root, no trace of bulb-like or tuber-like swellings at base.

Delaware.—Fawkes Run; Williamson.

Chester.—Paoli; Serpentine Ridge (B. Long); Cedar Barrens; Unionville.

— Nottingham Barrens.

Insert:

†70A. JUNCOIDES BULBOSUM (Wood) Small.

Occasional on moist open barren. Plant not tufted, one or occasionally two stems from one root, bulb-like or tuber-like swellings at base evident, sometimes large.

Chester.—West Chester.

— Nottingham Barrens.

†75. SMILAX HERBACEA CRISPIFOLIA Pennell.

Intergrades with the species, *S. herbacea* L. of moist woodland, though commonly distinguishable. Undoubtedly a xerophytic derivative of this. Add:

Delaware.—Preston Run; Glen Riddle.

Chester.—West Chester (S. S. Van Pelt).

Some specimens from Cedar Barrens and Nottingham Barrens appear transitional to species.

†78. SISYRINCHIUM MUCRONATUM Michx. Add:

Delaware.—Williamson.

Chester.—Nottingham Barrens.

Insert:

78A. GYROSTACHYS BECKII (Lindl.) Stone.[9]

Probably occasional on dry open barrens.

Newcastle.—Centerville (A. Commons).

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[9] *Annual Report New Jersey State Museum* (1910), 375.

‡79. Gyrostachys gracilis (Bigel.) Kuntze. Add:
Delaware.—Wawa.
Chester.—Sugartown Barrens.

Insert:

79a. Leptorchis liliifolia (L.) Kuntze.
Occasional on moist shaded banks.
Chester.—Cedar Barrens; Unionville.

80. Leptorchis loeselii (L.) MacM. Add:
Chester.—Nottingham Barrens.

*90. Quercus marylandica Muench.
Hybridizes freely with other species.
Q. marylandica x *velutina ?*
Delaware.—Middletown Barrens.
Q. marylandica x *stellata ?*
Delaware.—Williamson.
Chester.—Nottingham Barrens (B. Long).

†92. Quercus stellata Wang. Add:
Newcastle.—Centerville (A. Commons).

†94. Quercus prinoides Willd. Add:
Newcastle.—Centerville (A. Commons).
Q. prinoides x *alba ?*
Chester.—Unionville.

†95. Comandra umbellata (L.) Nutt. Add:
Delaware.—Mineral Hill; Wawa.
Chester.—Paoli.

*97. Talinum teretifolium Pursh. Add:
Chester.—Unionville.
Newcastle.—Centerville (A. Commons).

*99. Cerastium oblongifolium Torr. Add:
Chester.—Marshallton (B. Long).
Newcastle.—Centerville; Mt. Cuba (A. Commons).

*100. Arenaria stricta Michx. Add:
Newcastle.—Centerville (A. Commons).

102. Thalictrum revolutum D. C. Add:
Delaware.—Wawa (leaves glandular-puberulent beneath).

†104. ARABIS LYRATA L. Add:

Newcastle.—Centerville (A. Commons).

105. SAXIFRAGA VIRGINIENSIS Michx. Add:

Chester.—Marshallton (B. Long).
Newcastle.—Centerville (A. Commons).

107. RUBUS FRONDOSUS Bigel. Add:

Chester.—West Chester.

Insert:

‡107A. RUBUS VILLOSUS Ait.

Frequent on edge of dry barrens. All have one-flowered branches, but I cannot distinguish satisfactorily *R. villosus enslenii* (Tratt.) from the species. The form I assume typical has three distinct leaflets, sharply serrate, others (indicated by asterisk) have leaves 1–3-foliate, coarsely toothed, and may be *R. invisus* (Bailey) Britton.

Delaware.—Fawkes Run* (B. H. Smith); Blue Hill; Williamson.*

Chester.—Serpentine Ridge*; West Chester.

110. ROSA HUMILIS Marsh. Read:

There seem to be two tendencies in this species with us, extreme forms seeming quite different, but I find it impossible satisfactorily to separate intermediates. Any lines of separation seem artificial. Both are frequent on open barren and about margin of greenbrier.

A. Leaves lanceolate to lanceolate-ovate, acutish to acuminate at apex, finely and sharply serrate, 2.5–4 cm. long. Spines slender, straight. Fruiting pedicels slender. Plant low, of drier situations. Probably to be considered typical *R. humilis* Marsh.

Delaware.—Fawkes Run; Mineral Hill; Williamson.

Chester.—Sugartown Barrens; Cedar Barrens.

B. Leaves broadly ovate to orbicular-ovate, mostly rounded to acutish at apex, more coarsely serrate, 2–4 cm. long. Spines stouter, somewhat recurved. Fruiting pedicels stouter. Plant taller, of moister situations. Possibly this the *R. palustris* of Marshall.

Delaware.—Bear Hill; Middletown Barrens; Williamson; Glen Riddle; Wawa.

Chester.—Paoli; Serpentine Ridge; West Chester; Brinton's Quarry; Unionville.

— Nottingham Barrens.

Insert:

110A. Malus coronaria (L.) Mill.
In border-woodland.
Chester.—Unionville.

111. Aronia nigra (Willd.) Britton. Add:
Newcastle.—Centerville (A. Commons).

119. Meibomia rigida (Ell.) Kuntze. Add:
Chester.—Nottingham Barrens (E. B. Bartram).

Insert:

123A. Lespedeza nuttallii Darl.
Probably occasional on dry open barren.
Delaware.—Mineral Hill.

†125. Lespedeza virginica (L.) Britton. Add:
Chester.—Nottingham Barrens (A. S. Haines).

126. Lespedeza hirta (L.) Hornem. Read:
Frequent on dry open barren and margin of greenbrier.
Delaware.—Preston Run; Lenni.
Chester.—West Chester.
— Nottingham Barrens (A. S. Haines).

131. Linum intercursum Bicknell.[10] Read:
Occasional on dry open barren. Mr. Bicknell has recently pointed out reasons for considering our plant, in the north mainly restricted to the Coastal Plain, as distinct from *L. floridanum* (Planch.) Trel. of the south.
Delaware.—Bear Hill.
Chester.—Paoli (E. B. Bartram); Sugartown Barrens.
— Nottingham Barrens (A. S. Haines, B. Long).

†143. Helianthemum majus (L.) B. S. P. Add:
Chester.—Cedar Barrens.
Newcastle.—Centerville (A. Commons).

144. Lechea minor L. Add:
Newcastle.—Centerville (A. Commons).

147. Viola pedata linearilopa D. C. Add:
Delaware.—Fawkes Run (W. Stone).

[10] *Bull. Torr. Bot. Club*, XXXIX (1912), 418.

†148. VIOLA FIMBRIATULA Sm. Add:

Chester.—Paoli; Marshallton (B. Long).

Newcastle.—Centerville.

†149. KNEIFFIA LINEARIS (Michx.) Spach. Read:

Local on dry open barren and banks. Our plant appears to ha capsules less densely and permanently pubescent than in the coast plant. In similar situations, less frequent than *K. fruticosa*, wi which to some extent it may intergrade.

Delaware. Preston Run (J. W. Harshberger); Mineral Hi Williamson; Wawa.

Chester. Serpentine Ridge; Cedar Barrens.

Nottingham Barrens.

150. KNEIFFIA FRUTICOSA (L.) Raimann. Read:

Common on dry open barren and banks.

Delaware.—Mineral Hill; Williamson.

Chester.—Paoli; Sugartown Barrens; Serpentine Ridge; Ced Barrens; West Chester; Unionville.

Insert:

150A. ZIZIA AUREA (L.) Koch.

Local in moist soil.

Chester. Nottingham Barrens (B. Long).

154. AZALEA NUDIFLORA L. Read:

Frequent on edges of woodland or thicket.

Delaware.—Mineral Hill; Wawa.

Chester. Unionville.

Nottingham Barrens.

Insert:

154A. AZALEA NUDIFLORA GLANDIFERA Porter.

Local on edges of woodland or thicket. Pubescence of corolla-tul and capsule more or less glandular.

Delaware. Williamson.

Chester. West Chester.

Insert:

158A. VACCINIUM CORYMBOSUM L.

Occasional on dry barren or edges of woodland. Leaves pube cent on midrib and veins beneath.

Chester. Paoli.

Insert:

158B. VACCINIUM CÆSARIENSE Mackenzie.[11]

Occasional on dry barren or edges of woodland. Leaves quite glabrous on both surfaces.

Chester.—Sugartown Barrens.

159. VACCINIUM ATROCOCCUM (Gray) Heller. Read:

Occasional on dry barren or edges of woodland. Leaves pubescent over entire lower surface. Judging by leaf pubescence alone, we have three tall blueberries occasional upon the Serpentine. I have not had opportunity to collect in this habitat flowers or fruit of *corymbosum* or of *cæsariense*.

Delaware.—Williamson; Wawa.

Chester.—Paoli (E. B. Bartram, B. Long); Sugartown Barrens; West Chester.

161. VACCINIUM VACILLANS Kalm.

Leaves quite glabrous beneath. Add:

Chester.—Nottingham Barrens.

Insert:

161A. VACCINIUM VACILLANS CRINITUM Fernald.[12]

Occasional or local in borders of woodland. Leaves pubescent beneath.

Chester.—Nottingham Barrens.

Insert:

165A. GENTIANA VILLOSA L.

Dry woodland. Beside the following specimen seen, Dr. Samuel Trimble has mentioned to me finding this species upon the Serpentine at Williamson.

Newcastle.—Centerville (A. Commons).

166. ASCLEPIAS PURPURASCENS L. Add:

Delaware.—Mineral Hill.

Chester.—Paoli.

*167. ASCLEPIAS VERTICILLATA L. Add.

Newcastle.—Centerville (A. Commons).

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[11] *Torreya*, X (1910), 230.

[12] *Rhodora*, XIII (1911), 235.

*170. Scutellaria parvula ambigua (Nutt.) Fernald. Add:

Chester.—Serpentine Ridge.

— Nottingham Barrens.

Insert:

172a. Leptandra virginica (L.) Nutt.

Occasional in moist soil. Our plant has the leaves downy-pubescent beneath; the normal plant in this district has leaves smooth or less pubescent beneath.

Chester.—West Chester.

— Nottingham Barrens (B. Long).

176. Houstonia cœrulea L. Add:

Chester.—Paoli.

— Nottingham Barrens.

‡177. Mitchella repens L. Add:

Chester.—Paoli; Cedar Barrens.

178. Galium pilosum Ait. Add:

Chester.—Nottingham Barrens (B. Long).

180. Lonicera sempervirens L. Add:

Delaware.—Williamson.

182. Hieracium venosum L. Add.

Delaware.—Mineral Hill.

Chester.—Paoli (this plant, green, with two stem-leaves, may be *H. marianum* Willd. I cannot distinguish the form).

191. Lacinaria spicata (L.) Kuntze. Add:

Chester.—Nottingham Barrens (A. S. Haines).

195. Solidago aspera Ait.

Apparently an extreme form of *S. rugosa* Mill.

*206. Aster depauperatus (Porter) Fernald.

I prefer to consider this a species distinct from *Aster parviceps* (Burgess) Mack. and Bush, with which Prof. Fernald unites it. Our plant is very slender, its stem smooth or nearly so, its stem-leaves linear, those of the branches minute and mostly appressed, its heads slightly smaller—all points of contrast—while quite significant is the wide break in range between the two. *Aster depauperatus* ap-

pears to be known as yet only from the Serpentine Barrens of Delaware, Chester, and Lancaster Counties, Pennsylvania, apparently strictly restricted to such soil. Doubtless it extends over the boundary into Cecil County, Maryland, and possibly beyond. As Serpentine Barrens exist only in this corner of Pennsylvania, and do not exist at all in West Virginia, the range as given in the new *Gray's Manual* is impossible. If the plant does occur as reported in West Virginia, it must be on some other soil, not on adjacent Serpentine areas.

208. ANTENNARIA NEODIOICA Greene. Add:
Chester.—Cedar Barrens.

210. ANTENNARIA PLANTAGINIFOLIA (L.) Richards. Add:
Chester.—Nottingham Barrens (B. Long).

†212. HELIOPSIS HELIANTHOIDES (L.) Sweet.

Varies greatly even in same colony in relative width of leaf, also in roughness of its upper surface from nearly smooth to quite scabrous. Within our range, I do not think *H. scabra* Dunal can be distinguished.

†215. SENECIO BALSAMITÆ Muhl. Add:
Newcastle.—Centerville (A. Commons).

II. EMENDATIONS OF THE LIST OF OCCASIONAL SPECIES OF THE CONOWINGO FLORA.

Insert:
0A. BOTRYCHIUM OBLIQUUM Muhl.
Delaware.—Williamson.

Insert:
0B. ADIANTUM PEDATUM L.
Chester.—Cedar Barrens.

Insert:
6A. PASPALUM LÆVE AUSTRALE Nash.
Chester.—Serpentine Ridge.

7. PASPALUM LÆVE CIRCULARE (Nash) Stone.[13] Add:
Chester.—Nottingham Barrens (B. Long).

12. PANICUM LINDHEIMERI Nash. Add:
Chester.—Nottingham Barrens (B. Long).

[13] *Annual Report New Jersey State Museum* (1910), 187.

Insert:

12A. PANICUM MERIDIONALE Ashe.

Chester.—Nottingham Barrens (B. Long).

Insert:

15A. CHÆTOCHLOA IMBERBIS (Poir.) Scribn.

Delaware.—Williamson.

Strike out:

16. PANICULARIA NERVATA (Willd.) Kuntze.

17. CYPERUS RIVULARIS Kunth. Not *C. diandrus* Torr. as previously reported.

Insert:

19A. SCIRPUS VALIDUS Vahl.

Chester.—Cedar Barrens.

Insert:

19B. RYNCHOSPORA SMALLII Britton.

Chester.—Marshallton (B. Long).

Insert:

20A. CAREX VESTITA Willd.

Chester.—Nottingham Barrens.

Insert:

20B. CAREX GRANULARIS Muhl.

Delaware.—Williamson.

Insert:

20C. CAREX LAXICULMIS Schwein.

Newcastle.—Centerville (A. Commons).

Insert:

20D. CAREX PENNSYLVANICA Lam.

Delaware.—Wawa.

Newcastle.—Centerville (A. Commons).

Insert:

20E. CAREX NIGROMARGINATA Schwein.

Newcastle.—Centerville (A. Commons).

Insert:

20F. Carex stipata Muhl.

Chester.— Nottingham Barrens.

Insert:

20G. Carex rosea Schkuhr.

Delaware.— Bear Hill.

Insert:

20H. Carex cephalophora Muhl.

Delaware.—Glen Riddle.

Insert:

20I. Carex muhlenbergii Schkuhr.

Delaware.—Wawa.

Insert:

21A. Uvularia perfoliata L.

Delaware.—Preston Run; Bear Hill.

22. Polygonatum commutatum (R. and S.) Dietr. Add:

Delaware.—Glen Riddle.
Chester.—Cedar Barrens.

Insert:

23A. Sisyrinchium gramineum Curtis.

Chester.—Paoli.

33. Benzoin æstivale (L.) Nees.

Delaware.— Williamson.

Insert:

34A. Rubus argutus Link.

Chester.—Cedar Barrens.
— Nottingham Barrens (B. Long)

36. Amelanchier lævis Wiegand.

Chester.— Unionville (Dr. K. M. Wiegand determines this specimen as a probable hybrid between *A. lævis* and *A. oblongifolia* (T and G.) Roem.
— Nottingham Barrens (B. Long).

Insert:

36A. PRUNUS AMERICANA Marsh.

Chester.—Brinton's Quarry.

Insert:

36B. CRACCA VIRGINIANA L.

Newcastle.—Centerville (A. Commons.)

Insert:

37A. GERANIUM MACULATUM L.

Delaware.—Mineral Hill.

Insert:

43A. RHUS RADICANS L.

Chester.—Cedar Barrens.

Insert:

46A. VIOLA EMARGINATA Le Conte.

Delaware.—Bear Hill.

Insert:

46B. VIOLA CONSPERSA Reichenb.

Chester.—Marshallton (B. Long).

Insert:

47A. CHAMÆNERION ANGUSTIFOLIUM (L.) Scop.

Chester.—Nottingham Barrens (B. Long).

Insert:

48A. CICUTA MACULATA L.

Delaware.—Williamson.

63. CHIMAPHILA UMBELLATA (L.) Nutt. Add:

Chester.—Nottingham Barrens.

Insert:

53A. AZALEA VISCOSA GLAUCA Michx.

Chester.—Nottingham Barrens.

Insert:

58A. CONVOLVULUS SPITHAMÆUS L.

Delaware.—Williamson.

Strike out:

61. SCUTELLARIA PILOSA Michx.

62. SCUTELLARIA INTEGRIFOLIA L. Add:

Chester.—Unionville.

Strike out:

65. LEPTANDRA VIRGINICA (L.) Nutt.

Insert:

68A. GALIUM CLAYTONI Michx.

Chester.—Nottingham Barrens.

Insert:

71A. KRIGIA VIRGINICA (L.) Willd.

Appearing as if introduced.
Delaware.—Williamson.
Chester.—Sugartown Barrens.

Insert:

73A. EUPATORIUM PURPUREUM L.

Delaware.—Williamson.

THE PROTOCONCH OF ACMÆA.

BY WILL F. THOMPSON.

The protoconchs or embryonic shells of the Mollusca have been used by various writers as indicating the status of the various groups and their line of descent. The Acmæidæ have many primitive characters, and it would be expected that the embryonic stages of the shell would show a like condition. It has been stated that these forms possess a coiled nautiloid protoconch by Grabau, '03; Pelseneer, '06; Fisher, '04; Verrill, '96, and others. In a recent article by Morse, '10, this is declared erroneous, and figures and descriptions are given of a stage of *Acmæa testudinalis* in which there is shown "simply a cæcal-like shell with slight dorsal flexure" and "a slight elongated area rounded anteriorly" at either side where the embryonic shell joins the permanent.

The specimens of *Acmæa* cited by Dr. W. K. Fisher were given to me by Dr. Harold Heath, with the request that I investigate them. I thank him for his kindness, as well as Dr. J. P. Smith.

The material was imbedded in very hard paraffin, either entire or in part decalcified, and sectioned. This method gave but poor results, and better were obtained by observing the specimens in reflected light under high powers of the microscope. By carefully working over the débris picked up with the young limpets, decollated shells were found without the embryo within them and hence in excellent condition for observation. All the material came from the tide pools of Monterey Bay, but the species could of course not be certainly identified.

The general appearance of the shell may be seen in fig. 1. A slight asymmetry is visible, the posterior apex of the protoconch being to the left of the adult axis, although symmetrical to that of the larva itself. In view of the presence in nearly related mollusks of naticoid and planorbid coils, this probably has but very little significance. The "lateral folds" of Morse, '10, are very evident and easily seen (fig. 2), leading, if seen from one side, to the appearance of a true spiral coil, but present on both sides. The right-hand one is in the greater number of cases slightly longer than the left, in harmony with the slight asymmetry. As may be seen in figs.

2 and 3, the margin of the embryonic shell and its connection with that of the permanent patelloid shell is in the plane of the lower edge of the lateral pouches or folds of Morse. The first of the growth lines of the patelloid shell run under the protoconch below

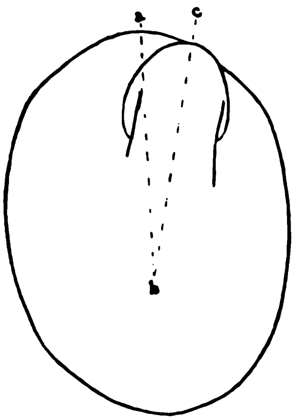

Fig. 1.—*Acmæa* sp. Protoconch on first of adult shell.

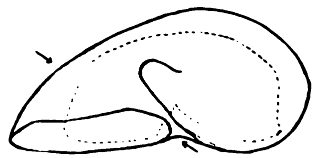

Fig. 2.—Protoconch of *Acmæa* sp. from side, showing first of adult shell. Line of base of protoconch indicated by arrows.

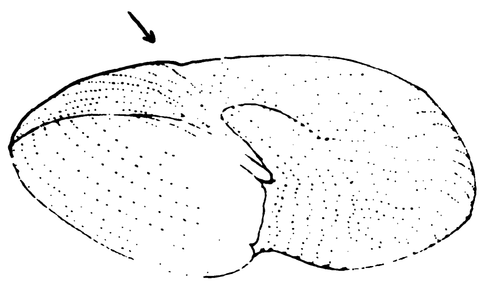

Fig. 3.—Protoconch and first of adult shell of *Acmæa* sp. showing growth lines, upper edge of adult shell indicated by the arrow. Camera lucida, looking at the bottom and one side.

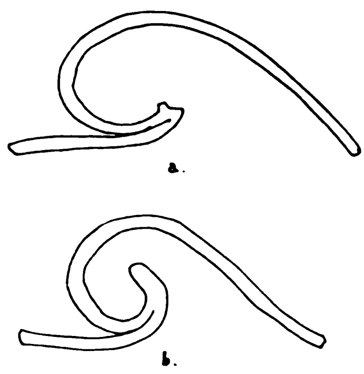

Fig. 4.—Protoconch of *Acmæa* sp. *a*, Sagittal section through centre of shell, on line of *bc* of fig. 1. *b*, Somewhat oblique section on line *ab* of fig. 1.

the middle of the lateral "pouches" (fig. 3), as may be seen in Morse's fig. 5, although his fig. 4 shows a different condition.

In sagittal section there is shown merely a cæcal-like shell with the suggestion of a coil in the form of the ridge or inner anterior margin of the protoconch (fig. 4*a*). This appearance is further strengthened by the section of a shell with the animal still within it (fig. 5). The shell in this has been slightly decalcified. By making a somewhat oblique section of one side (fig. 4*b*), a still

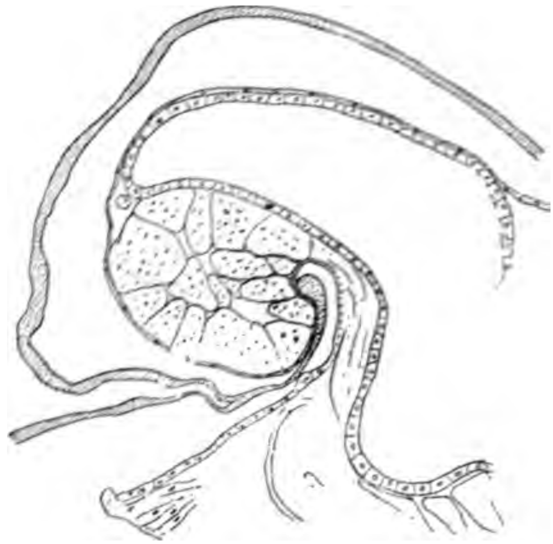

Fig. 5. *Acmæa* sp. Section of protoconch with portion of young still within it. Shell stippled.

more striking appearance of a coil is obtained. This is true of both sides of the protoconch. The lateral edges, then, of this ridge shown in the median sections of the shell are simply turned back or " coiled " to a greater degree than the central part and the lateral marks are the external evidences of this condition, the "folds" being the union of the ridge with the outer wall of the shell. This is shown in figs. 2 and 6.

If this were a true coil the lines of growth would be expected to bear it out. By observation under the high powers in direct reflected light it is possible to discern these lines in the species under consideration. They are very regular, clear, and well marked. In fig. 3 a camera lucida drawing is shown. Their center seems to be on the lower surface of the protoconch. Those of the lateral pouches are shown to be parallel to their long axis and not conformant below the shell to those behind them. What the significance of this state of affairs may be I cannot hazard a guess, and it appears as though its explanation must await the complete working out of the embryology which Patten was unable to carry so far. The embryo in the youngest stages which I sectioned occupies these corners with portions of the liver. Judging from the lines of growth, one would be tempted to think that these pouches were formed later

than the middle portion of the protoconch and subsequent to a resorption of the posterior edge. If they were remnants of a true coil it would be expected that growth should take place in them first.

As mentioned above, the liver, at the earliest stage I had, occupied a part of the protoconch with its large granulated cells (fig. 5). In company with it was one loop of the large, thin-walled alimentary canal. This is well past the veliger stage and when the embryo is fairly complex. There were no gills present. At a period slightly later than the stage represented in fig. 1, the protoconch is broken off, leaving a cicatrix. The lower part of the primitive shell seems in some cases at least to remain on the patelloid shell to form the posterior part of the cicatrix. This has been fully described by previous authors.

In conclusion, it may be stated that the protoconch gives more evidences of being a simple cæcal-like shell than coiled, although the evidences are open to other interpretations. The slight coil of the body and shell and a tendency of the shells to form more rapidly anteriorly than posteriorly at first would indicate the presence

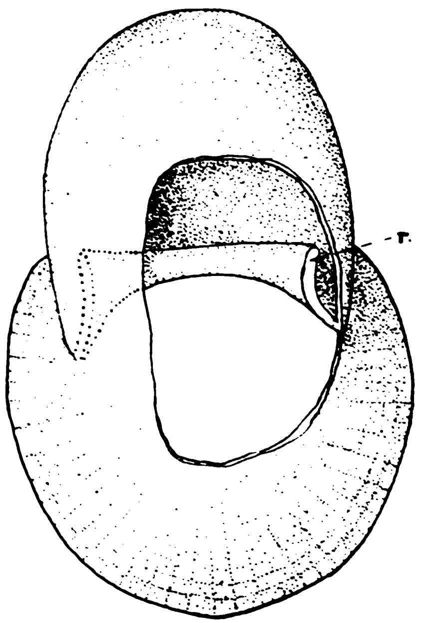

Fig. 6.—Protoconch and beginning of permanent shell of *Acmæa* sp. in optical section, from dorsal surface. *r*, Ridge at upper line of lateral pouch.

of a coil in the ancestral shell, which may have been altered by cænogenetic variation and the resorption of parts. The structure and disposal of the growth lines, the simple character of the lateral pouches and their small size in proportion to the size of the egg and larva, indicate that they are caused by something other than a coil. *Trochus*, *Natica*, *Nassa*, *Eolis*, or Ammonite and nautiloid protoconchs do not seem to differ much from the structure described above.

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The following Reports were ordered to be printed:

REPORT OF THE RECORDING SECRETARY.

Because, probably, of the division of Science into specialties, it becomes increasingly difficult to maintain interest in the meetings of a society devoted, as the Academy is, to research in the entire field of physics and natural history. In the absence of solicited communications taking more or less the form of lectures, and all the more likely to secure a moderate audience if illustrated by lantern views which would be even more attractive could they be presented in the form of moving pictures, there seems no reason, beyond the requirements of routine business, generally irksome, for the holding of the sessions provided for by the by-laws. The practice of reporting in verbal communications the results of current original research has almost entirely ceased, although thirty or forty years ago it was a most important means of sustaining the interest of the meetings, giving distinction to the minutes, and adding to the value of the publications.

When Leidy, or Cassin, or Meehan, or Cope, or Ryder, or Heilprin had found out anything, had a new fact or the confirmation of an old one to tell of, they resorted to the "verbal," a substantive with quite a special significance as used in the Academy. These verbal communications were generally reported by the authors for the pages of the PROCEEDINGS. For some years back, to the impoverishment of the meetings, such contributions to science are either embedded in a formal paper presented for publication and seldom or never read except by title, or they are made known to the world in little notes to *Science* or some other current periodical.

The consideration of a possible remedy for the existing subsidence of interest in the meetings of the Academy has been referred to a committee, and it may be that the result will be beneficial.

Thirteen meetings have been held since last November, with an average attendance of fifty-one—a much higher average than has been recently reported. This is, however, due to the extraordinary attendance on the sessions of the meeting held March 19, 20, and 21, in commemoration of the one hundredth anniversary of the

founding of the Academy. The event was considered memorable by the entire learned world, as evinced by the reception of 405 letters, telegrams and cards of acknowledgment and congratulation from institutions and correspondents and the appointment of 194 delegates by learned societies at home and abroad.

A full report of this most interesting event in the history of the Academy has been printed and distributed as the first part of the fifteenth volume of the quarto JOURNAL. The entire volume has been specially prepared and is now placed before the meeting in a form befitting in its dignity the culmination of the Academy's distinguished contributions to science since 1817, when the publication of the unpretentious first number of the octavo JOURNAL was evidence of the sustained faith of the founders in the dignity of their mission. The contrast of the struggling Academy of 1817, meeting in the little house up Gilliam's Court, with the society as now established and endowed is scarcely greater than that of the first issued volume with the sumptuous quarto just completed.

The centenary meeting was addressed by the Mayor, the President, the Recording Secretary, and twenty-four members and correspondents. Nearly all of the communications, presented also as contributions to the commemorative quarto, were epitomized for the preliminary report in the PROCEEDINGS of last March. The celebration culminated in a banquet attended by 160 delegates, members, and guests, at which eight congratulatory addresses were made after the discussion of an elegant and sufficient bill of fare.

The permanent memorials of the event will consist of the volume of the JOURNAL now on the table, an index to the publications of the Academy brought to the end of 1910, and a history of the society by the Recording Secretary. The commemorative quarto is now before the meeting. The index consists of a record of all the contributions to the JOURNAL and PROCEEDINGS during the period defined, and a reference to every scientific name occurring in the volumes. The alphabetical arrangement of the latter has been completed and about two-thirds of the list is in type, forming the second section of the volume, the first consisting of the catalogue of papers and "verbals." The entire volume will contain about thirteen hundred pages. While the history requires only the final chapter (an account of the centenary celebration) for completion, no arrangement has yet been made for the publication of the volume, as the preparation of the other works referred to has been so engrossing during the year that it would have been impossible

to devote necessary time to the additional task. The reading of the proof of the index, especially, has been most exacting, and occasion is taken to make grateful acknowledgment to Mr. William J. Fox and Dr. Henry A. Pilsbry for efficient assistance in this tiresome and laborious work. Mr. Fox also gave indispensable assistance in the preparation of the centenary volume.

The ordinary meetings have been addressed by Messrs. Leffman, Calvert, Stewardson Brown, Tucker, Bailey, Smith, Harshberger, Dahlgren, Spitzka, Trotter, Bascom, and Skinner.

Fifty-three papers have been presented for publication, as follows: Edgar T. Wherry, 3; James A. G. Rehn and Morgan Hebard, 3; Henry A. Pilsbry and Amos P. Brown, 2; Henry W. Fowler, 2; Edward G. Vanatta, 2; Witmer Stone, 2; Thomas H. Montgomery, 1; John M. Clarke, 1; J. A. Nelson, 1; Carlotta J. Maury, 1; Harriet W. Wardle, 1; Frederick W. True, 1; Henry Skinner, 1; Florence Bascom, 1; George A. Boulenger, 1; John W. Harshberger, 1; Thomas Wayland Vaughan, 1; Spencer Trotter, 1; George Howard Parker, 1; Sir William Thiselton-Dyer, 1; J. W. von Wijhe, 1; Marshall A. Howe, 1; W. J. Holland, 1; William H. Dall, 1; Benjamin Smith Lyman, 1; Henry G. Bryant, 1; A. N. Caudell and Morgan Hebard, 1; John M. Macfarlane, 1; Henry H. Donaldson, 1; George A. Koenig, 1; Thomas H. Morgan, 1; Clarence B. Moore, 1; James E. Ives, 1; Addison E. Verrill, 1; Henry F. Osborn, 1; Harold S. Colton, 1; S. Stillman Berry, 1; W. L. McAtee, 1; T. Fukuda, 1; Edwin G. Conklin, 1; Harold Heath and Ernest B. McGregor, 1; Burnett Smith, 1; Henry A. Pilsbry, 1; H. von Ihering, 1; R. W. Shufeldt, 1.

Four of these have been withdrawn by the authors, twenty-four are contributions to the JOURNAL, and the others constitute the portions of the year's PROCEEDINGS so far issued.

Mr. Moore's paper concludes the fourteenth volume of the JOURNAL. It consists of 161 pages, beautifully illustrated with many halftones in the text and eight superb plates in color, fully sustaining the reputation established by the earlier publications of Mr. Moore, to whom the Academy is as usual indebted for the entire cost of issue.

The commemorative volume of the JOURNAL consists of 756 pages and 59 plates, 6 of which are in colors.

Additional publications have been issued during the year as follows: PROCEEDINGS, 550 pages, 21 plates; ENTOMOLOGICAL NEWS, 484 pages, 20 plates; TRANSACTIONS OF THE AMERICAN ENTOMO-

LOGICAL SOCIETY (Entomological Section of the Academy), 400 pages, 3 plates; MANUAL OF CONCHOLOGY, 168 pages, 20 plates. The entire issue for the year, therefore, amounts to 2,358 pages and 123 plates.

Nineteen members and four correspondents have been elected. The deaths of twelve members and of six correspondents have been announced, while three members have resigned.

More than a mere record should be made of the loss sustained by the Academy in the deaths of Edward Potts and Thomas Harrison Montgomery. Mr. Potts had been forced by impaired health to discontinue, a few years ago, his active association with the Academy, but his interest in science remained unabated to the last. His work on the natural history of the fresh-water sponges, the results of which the Academy had the honor of publishing, has been recognized as of singular accuracy and thoroughness.

Dr. Montgomery was the first contributor to the commemorative volume, and the announcement of his death at the first session of the centenary meeting was a pathetic incident of the proceedings. Appropriate action was taken by the Academy, an appreciative minute, prepared by Dr. Calvert, having been placed on the minutes and published.

The Hayden Medal, on the recommendation of the properly constituted committee, was awarded to Professor John C. Branner, of the Leland Stanford Jr. University, in recognition of his distinguished work in geology.

Daniel J. Fay, Robert Rosenbaum, and Delos E. Culver have served terms as Jessup Fund students.

The will of the late Mrs. Catherine E. Beecher provides for the endowment of the J. F. Beecher Memorial Laboratory for the study of Biology and Anthropology in the Academy. The amount of the fund, not yet definitely reported, is to be invested for ten years before the income can be available. The proper officers have been instructed to prepare the papers required by the acceptance of the legacy.

The popular evening course of free lectures, conducted in conjunction with the Ludwick Institute, was given as usual on Monday and Thursday evenings, January 8 to March 7:—

Three lectures on Familiar Birds and their Life Histories were delivered by Mr. Witmer Stone; one on The Organization of the Pennsylvania Department of Health by Dr. B. F. Royer; one on The Purity of the Streams of Pennsylvania by Mr. F. Herbert Snow; three on Entomology by Dr. Henry Skinner; three on Problems

in the Study of Faunas by Dr. Henry A. Pilsbry; three on Studies in Local Plant Life by Mr. Stewardson Brown, and two on Ancient and Modern Man by Dr. Spencer Trotter.

The afternoon course for students of the Girls' High Schools of Philadelphia, inaugurated last year, was continued, beginning October 2, and was largely attended.

Two lectures each were delivered by the following speakers: Dr. Henry A. Pilsbry, on Crustacea and Mollusks; Dr. J. Percy Moore, on Reptiles and Mammals; Mr. Witmer Stone, on Birds; Mr. Stewardson Brown on Plants; and one each by Dr. Philip P. Calvert and Dr. Henry Skinner, on Insects.

It is manifest that the year has been one of unusual interest and activity, and there is no reason to doubt that the fine record commemorated last March will be continued during the next century, although conditions, which have already changed, may undergo further modification. A reasonable prediction as to what these modifications may be when the second centenary of the Academy will be celebrated by our successors in March, 2012, would be a matter of serious interest could it now be made.

Edward J. Nolan,
Recording Secretary.

REPORT OF CORRESPONDING SECRETARY.

During the year the deaths of the following-named correspondents occurred: Sir Joseph D. Hooker, Professor John Duns, Professor Eduard Strasburger, and Professor Rudolph Hoernes. The death of the Reverend Stephen Bowers in 1907 and of Professor Adolph Bastian at an unascertained date were also announced. Elections of correspondents were as follows: Professor Viktor Goldschmidt, Dr. Carlotta J. Maury, Professor John Casper Branner, and Dr. Charles Haskins Townsend.

Invitations to participate in the following-named events were received: The annual meeting of the American Anthropological Association; the XIIIth International Congress of Americanists, at which the Academy was represented by Sir Thomas Lauder Brunton; the XIVth International Congress of Anthropology and Prehistoric Archeology; the two hundreth anniversary of the founding of the Academy of Sciences, Belles-Lettres, and Arts of Bordeaux; the XXIst annual convention of the German Dendrological Society; the Second International Congress of Entomology, to which Dr.

Henry Skinner, Professor Philip P. Calvert, and Dr. W. J. Holland were appointed delegates; the International Forestry Congress; the dedication exercises of the New York State Education Building, at which Professor Henry F. Osborn represented the Academy; the XVIth International Congress of Orientalists; the one-hundred and twenty-fifth anniversary of the founding of the University of Pittsburgh, at which Mr. George H. Clapp served as a delegate, and the inauguration exercises of The William H. Rice Institute, on which occasion Professor Allen J. Smith and Professor Hugo de Vries were the Academy's delegates. Formal addresses or simpler letters of congratulation were forwarded to the executive officers of all of the events named.

The year 1912 will be remembered as one especially noteworthy in the history of the Academy, because it marked the completion of the first century of the Academy's corporate existence. In connection with the celebration of this event the volume of correspondence was much augmented, especially by that conducted on behalf of the Sub-Committee on Invitations, upon which the Corresponding Secretary served.

During the month of January the invitation prepared at the close of the last fiscal year was mailed, along with a provisional program and a card requesting replies, to 786 learned societies and institutions in all parts of the world and to the full list of correspondents whose addresses have been verified. The reponses were most gratifying, both in number and character. They began to arrive almost immediately, came in increasing volume until the opening of the celebration, and continued to be received during and even after that event. In all four hundred and five institutions responded, of which three hundred and twenty-five sent congratulatory addresses, letters or telegrams, many of which were very gracefully expressed and handsomely executed. A full list of these is given and many of the letters are quoted in full in the memorial volume now before the meeting. A selection of some of the more interesting or beautiful ones is on exhibition in the reading room. One hundred and forty-seven institutions appointed one hundred and ninety-four delegates. Excluding duplications, one hundred and fifty-seven persons were appointed, of which one hundred and twelve are known to have been in attendance. Of the correspondents fifty-two sent letters of congratulation and a number regrets, and thirteen were present at the meetings.

Finally, after letters had ceased to be received, an acknowledgment

expressing appreciation and signed by the President and Secretaries was sent to those institutions, delegates, and correspondents who had shown their interest in the anniversary.

Many letters asking for information were answered by the Corresponding Secretary personally or handed for reply to other members of the scientific staff.

Statistics of the year's correspondence follow:

Communications received:

Acknowledging receipt of the Academy's publications	144
Transmitting publications to the Academy	63
Requesting exchanges or the supply of deficiencies	1
Invitations to learned gatherings, etc.	20
Notices of deaths of scientific men	12
Circulars concerning the administration of scientific institutions, etc.	41
Photographs and biographies of correspondents	8
Letters from correspondents	95
Miscellaneous letters	767
Total received	1,151

Communications forwarded:

Acknowledging gifts to the library	1,198
Requesting the supply of deficiencies in journals	133
Acknowledging gifts to the museum	139
Acknowledging photographs and biographies	10
Letters of sympathy and congratulation, addresses, etc.	19
Diplomas and notices of election of correspondents and of appointment of delegates	12
Miscellaneous letters	386
Annual reports, circulars, etc.	2,185
Invitations..	984
Acknowledgments	543
Total forwarded	5,609

Respectfully submitted,
J. Percy Moore,
Corresponding Secretary.

REPORT OF THE LIBRARIAN.

The additions to the library received, recorded, and placed during the past year have amounted to 8,793. They have been received from the following sources:

Exchanges	3,662
I. V. Williamson Fund	2,397
United States Department of Agriculture....	950
General Appropriation	786
Authors...	225
Mrs. Henry C. McCook	139
James Aitken Meigs Fund	117
Editors....	72
Colorado Agricultural College	70
Thomas B. Wilson Fund	48
Imperial Department of Agriculture of the British West Indies	28

United States Bureau of Education	25
United States Department of the Interior	20
Pennsylvania Department of Health	15
New York Agricultural Experiment Station	15
United States Treasury Department	14
University of Nebraska	14
Government of Costa Rica	13
United States Department of Commerce and Labor	13
Imperial Geological Survey of Japan	12
Pan-American Union	11
East Indian Government	10
Washington Geological Survey	8
William J. Fox	8
Commission Géologique de Finlande	7
Massachusetts Agricultural Experiment Station	7
Edward J. Nolan, M.D.	7
Publication Committee of the Academy	6
Pennsylvania Department of Agriculture	6
Ministerio de Agricultura, Argentine Republic	4
Mississippi State Geological Survey	4
Maryland Geological Survey	4
Geological Survey of Georgia	4
Duc d'Orleans	4
Danish Government	4
Arizona Horticultural Commission	3
Estacion Sismologica de Cartuja	3
Department of Trade and Customs, Australia	3
Commission of Conservation, Canada	3
New Mexico College of Agriculture	3
French Government	3
Illinois State Geological Survey	3
Dr. Henry Skinner	2
Government of Formosa	2
Illinois Bureau of Labor Statistics	2
Wisconsin Geological and Natural History Survey	2
Wyoming Experiment Station	2
Chief Secretary of New South Wales	2
Delaware County Institute of Science	2
Geological Survey of New Jersey	2
Survey of India	2
Dr. Thomas Biddle	2
Surgeon-General's Office, U.S.A.	1
Dr. H. A. Pilsbry	1
Fondation pour l'Internationalisme	1
Presbyterian Historical Society	1
Southern Pacific R. R. Co.	1
Bentham Trustees, Kew Gardens	1
United States Brewers' Association	1
Witmer Stone	1
Commissioners on Fisheries and Game, Massachusetts	1
National Academy of Sciences	1
Department of Fisheries, Pennsylvania	1
Edgar T. Wherry	1
Steiermärkische Landesmuseum, Joanneum	1
Arthur H. Lea	1
Pennsylvania Chestnut Tree Blight Commission	1
Sveriges Geologiska Undersokning	1
Geological Survey of Alabama	1
Cuerpo de Ingenieros de Minas del Peru	1
Albert I, Prince de Monaco	1
Commission Sismologique Centrale à St. Pétersbourg	1
New Jersey Agricultural Experiment Station	1
Missouri Bureau of Geology and Mines	1
Michigan Geological and Biological Survey	1

Of these 7,595 were pamphlets and parts of periodicals, 1,046 volumes, 142 maps, and 10 sheets.

They were distributed to the various departments of the library as follows:

Journals	6,149
Agriculture	1,110
Geology	422
Botany	223
General Natural History	171
Entomology	133
Voyages and Travels	125
Anatomy and Physiology	89

Conchology..	65	Medicine....	13
Anthropology..	39	Chemistry..	12
Ornithology...	36	Mammalogy..	12
Geography.	32	Mathematics...	12
Helminthology..	28	Herpetology..	5
Physical Sciences	26	Miscellaneous	37
Mineralogy..	21		
Bibliography..	20		8,793
Ichthyology.	13		

No effort has been spared to keep the department of journals and periodicals up to its present very desirable standard of completeness.

The following journals have been added to the subscription list, complete sets having been secured when desirable:

Behavior Monographs. Baltimore.
Records of the Past. Washington.
Baessler-Archiv. Leipzig.
American Fern Journal. Port Richmond, N. Y.
Monatsschrift f. Kakteenkunde. Berlin.
Scottish Naturalist. Edinburgh.
Revue Zoologique Africaine. Bruxelles.
Mycologisches Centralblatt. Jena.
Zeitschrift f. Gärungsphysiologie. Berlin.
Aquarium. Philadelphia.
Internationale Mittheilungen f. Bodenkunde. Berlin.
Parasitology. Cambridge.
Zeitschrift f. Untersuchung der Nahrungs- und Genussmittel. Muenchen.
Memoirs of the Biological Laboratory, Johns Hopkins University, Baltimore.
Memoirs of the Wistar Institute of Anatomy and Biology, Philadelphia.
Zentralblatt f. Zoologie. Leipzig.
Revue française d'Ornithologie. Paris.
Austral Avian Record. Watford.
Zentralblatt f. normale Anatomie und Mikrotechnik. Berlin.
Leaflets of Philippine Botany. Manila.

The following new journals have been purchased:

Beiträge zur Rheinischen Naturgeschichte. 1849–53. Freiburg i. B.
Botanical Gazette. 3 vols. London.
Billotia. 1 vol. Paris.
Bollettino della R. Istituto Botanico dell' Università Parmense. 1892–93. Parma.
Transactions of the Geological Society of Australia. 1 vol. Melbourne.
Boletim de la Sociedad Broteriana. Vols. 1–22 (1880–1906). Coimbra.
Acta Hortus Bergianus. Vols. 1–4 (1891–1907). Stockholm.
Travaux Scientifiques de l'Université. Vols. 1–6 (1901–07). Rennes.
Mittheilungen des Badischen Zoologischen Vereins. Nos. 1–17 (1899–1905). Karlsruhe.
Correspondenzblatt f. Sammler von Insekten. 1860–61. Regensburg
Museum des Wundervollen, etc., 12 volumes (1810–13). Leipzig.
Naturalists' Journal. 8 volumes. London.
Annual Report and Transactions of the Plymouth Institution. Vols. 1–8. Plymouth.
Comptes Rendus des Congrès des Sociétés Savantes de Paris, etc. 1908.
Mitteilungen der Aargauischen Naturforschenden Gesellschaft. 1–8. Aarau.
Acta Hortus Botanicus Universitatis Imp. Jurjevensis. Vols. 1–11.
Mittheilungen der deutschen Gesellschaft f. Geschichte der Medizin und Naturwissenschaften. Vols. 1–8.
Berichte des physiologischen Laboratorium, etc., Universität. Vols. 1–20. Halle.

Berichte der geologischen Kommission der Königreiche Kroatien u. Slavonien.
Ornithologist. First Series. London.
Bulletin des Société Dauphinoise d'Éthnologie et d'Anthropologie. Vols. I–IV. Grenoble.

The exchange list has been increased by the addition of the following:

Aus der Heimat—für die Heimat. Leipzig.
Muzeumi Füzetek, Ásványtárának Ertesitöje. Kolosvar.
Städtisches Museum f. Völkerkunde. Publications. Leipzig.
Boletin de la Sociedad Phycis. Buenos Aires.
Mitteilungen der deutschen Dendrologischen Gesellschaft.
Atti, Società Lombarda di Scienze mediche e biologiche. Milano.
Anales, Centro de Estudios Sismologicos. Costa Rica.
Report of the Imperial Fisheries Institute. Tokyo.
Notes from the Royal Botanic Garden. Edinburgh.
Bulletin de la Société Académique de l'Arrondissement de Boulogne-sur-Mer.
Annales de la Société d'Emulation et d'Agriculture de l'Ain.
Mémoires de la Société de Vulgarisation des Sciences Naturelles des Deux-Sèvres. Niort.
Arxios de l'Institut de Ciencies. Barcelona.
Boletim do Museu Rocha. Ceara.
Butlleti, Club Montanyenc Associació de Ciencies Naturals i Excursións. Barcelona.
Science Reports of the Tohoku Imperial University.
Erdmagnetische Untersuchungen in Finnland. Helsingfors.
Mitteilungen der Naturforschende Gesellschaft zu Halle a. d. S.
Compte Rendu des Séances, Société de Physique et d'Histoire Naturelle de Genève.
Ceylon Marine Biological Reports.
Proceedings of the University of Virginia Philosophical Society.

Among the more important accessions may be specially mentioned:

Ehrhardt, Beiträge zur Naturkunde. Six vols. in two. Hannover, 1787–92.
Ortega, C. G. Novarum, aut rariorum plantarum, etc. Centurio I. Madrid, 1800.
Boudier, E. Icones Mycologicæ. Four vols. 1905–10.
Koenig, A. Avifauna Spitzbergensis. 1911.
Rothschild, W. Avifauna of Laysan. 1893–1900.

Mrs. McCook's gift, a selection from the library of the late Rev. Dr. McCook, provided a desirable increase, especially in the department of entomology.

Five hundred and forty-six volumes have been bound.

Thirty-two volumes on law, literature, and mechanics were transferred to the Free Library of Philadelphia.

Oil portraits of the President by Lazar Raditz and of the Recording Secretary by Charles Marquedent Burns have been presented. Due acknowledgments were made in each case.

I am indebted to my assistants, William J. Fox and Furman Sheppard Wilde, for relief from much of the routine work of the library during the year. Both have discharged their official duties

efficiently. The services of Mr. Fox especially have enabled me to devote much of my time to preparation for the centenary meeting and to the editing of the volumes commemorative of the celebration.

EDWARD J. NOLAN,
Librarian.

REPORT OF THE CURATORS.

The fire-proofing of the buildings, through the aid of the Commonwealth of Pennsylvania, has at last been completed. But few appreciate what this means, as our institution is fortunate in possessing the largest natural history library in this country, in addition to the museum, exceedingly rich in the type specimens of so much importance to science. The Entomological Department has been settled in its new quarters, which are said by the workers to fully meet their demands. This department is rapidly advancing along an economic path. The discoveries made in late years of the relationship between disease in animal life and insect life mean much in the universal battle now being waged against diseases in man, the ætiology of which has heretofore been surrounded by mystery.

The ornithological study collection has been moved back to its permanent quarters, where the specimens are kept in metal cases out of light and dust, while they are within very convenient reach of our investigators. It will be desirable to still further reduce the exhibit collection of our birds, as the many duplicates can better be preserved in storage cases and yet leave a sufficient number on exhibition to satisfy general educational purposes. The modern methods of mounting birds in their natural surroundings has been greatly extended in the local collection during the last year, and it supplies a good model for the rearrangement and extension of our general collection.

The Herbarium has been enlarged so that it will permit a more systematic arrangement of the botanical collections than has been heretofore possible.

The study collection of mollusks has been thoroughly arranged in the location provided for it two years ago and necessary cases for its expansion have been furnished. Detailed accounts of the work accomplished in these departments will be found in the subjoined special reports.

Modern cases are much needed in the northern museum, which has been fire-proofed and much improved in arrangement. With financial help, this wing can be made one of the most attractive in the museum.

The indirect lighting system employed will enable us, during this coming year, to display our exhibits on certain evenings in the month, so that those engaged throughout the day may make their studies in the various divisions of natural history in which they are interested.

The William S. Vaux Collection of minerals is being moved into the old library hall, which will relieve the crowding in the archæological collection and enable the Academy to exhibit the general mineral collection in near proximity.

Many valuable specimens have been added during the year. Several expeditions have been successfully conducted by our specialists, a rich harvest resulting from their research work.

Among the conspicuous and valuable accessions may be mentioned the mounted anthropoids and their respective skeletons, which have been added to the Dr. Thomas Biddle Collection. The new specimens were selected by Dr. Biddle to complete as nearly as possible the anthropoid family. The additions comprise a female and young gorilla, a large-eared chimpanzee, a young chimpanzee, and a baby orang-outang. Several rare monkeys and an Ornithorhynchus were also presented by Dr. Biddle.

Mr. Clarence B. Moore has continued his comprehensive investigations of the Indian mounds of the southern United States, resulting in the acquisition of many valuable specimens which make this collection one of the most complete of its kind ever brought together. Of special interest were two forms of pipes, one of the monoceramic and the other of the smoke-effigy type. A new type of grave was discovered on Red River, Arkansas.

The removal of the William S. Vaux Mineral Collection from the archæological floor will provide Mr. Moore with additional room for the material recently obtained.

Among other expeditions may be mentioned one by Messrs. Alfred M. Collins and E. Marshall Scull to British East Africa, where they collected for the Academy a valuable series of large mammals, now being prepared for mounting. The proper arrangement of this collection will demand a new wing to our building. Among the most valuable mammals may be mentioned the greater and lesser kudu, eland, giraffe, zebra, buffalo, and a variety of antelopes, hyenas, etc.

A collection of sections of the trunks of native forest trees, comprising almost all the species found in the Middle States, was presented by Mr. C. H. Jennings.

Through the courtesy of the New York Botanical Garden, Mr. Stewardson Brown was enabled to accompany Dr. N. L. Britton, Director of the Garden, on an expedition to Bermuda, where he made collections which added materially to the Academy's series of the plants of the island.

Through the liberality of Mr. Morgan Hebard, Mr. Rehn was enabled to spend the summer months in Florida and Texas, where together they made large and valuable collections of Orthoptera, half of which becomes the property of the Academy.

In addition to the work described in the special reports appended, Dr. J. Percy Moore has continued his investigation of the annelids obtained in the Pacific Ocean by the United States Bureau of Fisheries. He has identified and named many parasites and other worms submitted to him for identification.

Mr. Henry W. Fowler continues in charge of the fishes and has also identified recent accessions of collections of reptiles and batrachians. He has made a study of the catostomoid fishes in the general collection and prepared a report on the fishes of the Chincoteague region, Virginia.

The archæological collection is still under the care of Miss H. N. Wardle, who has identified and arranged the new specimens. A comprehensive catalogue of the department is in course of preparation.

The Curators are again under obligation to Messrs. S. S. VanPelt and Bayard Long for their continued work on the local collection of plants; to Mr. Morgan Hebard for the mounting of many entomological specimens, and to Dr. Amos P. Brown for the identification of several collections of invertebrate fossils forming part of the Isaac Lea Collection. This collection has for many years been under the care of the Rev. Leander T. Chamberlin, through whose generosity it has increased in extent and value from year to year. It is to be regretted that Dr. Chamberlin's ill health has compelled him to resign his honorary curatorship. The position has been filled by the appointment of Mr. Joseph Willcox.

Numerous local field trips have been taken by members of the museum staff, yielding valuable additions to the study series of fishes, reptiles, insects, mollusks, and plants.

One hundred and four storage cases and two hundred insect boxes have been purchased since our last report.

The museum is attracting a larger attendance of visitors than ever before, and many specialists throughout the country have made use of our study collections.

Specimens have been loaned to the following: Bryant Walker, L. A. Fuertes, Robert Ridgway, Paul Bartsch, K. A. Wiegand, Thomas Barbour, F. M. Chapman, L. A. Frierson, W. C. Bryant, H. H. Bartlett, E. W. Nelson, N. L. Britton, M. W. Lyon, C. W. Johnson, W. G. Mazyck, J. B. Henderson, J. A. Allen, J. C. Thompson, and J. O. Snyder.

Samuel G. Dixon,
Executive Curator.

Report of the Department of Mollusca.

The growth of the collection during the year has been normal, accessions having been received from ninety persons and institutions. Considerable collections of local mollusks have been made by Mr. Bayard Long, who also contributed a large and valuable series from the Magdalen and Prince Edwards Islands. A large quantity of Canadian material from Lake Huron was presented by Mr. A. D. Robertson. A good deal of foreign material has come in from the Hawaiian Islands, Mexico, South Africa, etc.

Twenty new storage cases have been purchased, each holding sixteen large trays, adding almost 1,000 square feet to our storage space.

Work during the year has been chiefly devoted to the study of Hawaiian snails, but considerable time has been spent in working up material from Florida, the Rocky Mountains, and Mexico. In collaboration with Dr. Amos P. Brown, Eocene mollusks from North Carolina, and Oligocene material from the Canal zone have been studied. Papers have been published or prepared for publication on all of these topics.

Mr. E. G. Vanatta has assorted and determined a large amount of local and other American material. His work has been seriously retarded by illness. Acknowledgments are due Miss Winchester, artist of the department, for helpful services throughout the year.

H. A. Pilsbry,
Special Curator.

Report of Curator of William S. Vaux Collections.

During the past year the principal accessions to the Wm. S. Vaux collection include a meteorite from South Africa, tourmaline, apatite,

stibiotantalite, neptuneite, and benitoite from California, glaucophane from Italy, struverite from South Dakota, tourmaline from Madagascar, and topaz from Texas.

F. J. Keeley,
Curator.

Report of the Custodian of the Isaac Lea Collection of Eocene Mollusca.

During the present year some important additions have been made to the Isaac Lea Collection.

These specimens represent three widely separated localities. From the limestone quarry near Wilmington, North Carolina, immediately overlying the Cretaceous bed, the specimens were collected personally by the writer. The writer also collected the specimens from the Oligocene bed at White Beach on Little Sarasota Bay, Florida. This bed, representing a small outcrop, is located farther south than any other known Oligocene horizon in the United States.

The series of fossils from the Panama Canal zone were collected by Dr. Amos P. Brown, and is a notable addition to the Isaac Lea Collection.

Until the present time none of the above-mentioned localities have been represented in any of the collections of the Academy.

All of these specimens have been identified by Dr. H. A. Pilsbry and Dr. A. P. Brown.

A list of the species from White Beach will be found in the *Additions to the Museum.* The collections from Wilmington and from the Panama Canal zone, containing sixty or more new species, have already been described in the Proceedings of the Academy.

Joseph Willcox.

REPORTS OF THE SECTIONS.

Biological and Microscopical Section.

Nine regular and several informal meetings of the Section have been held with the usual attendance. While the membership has not increased during the year, the interest in microscopical work has not diminished, although the change of room, necessitating the removal and rearrangement of the books and collections, somewhat interfered with the programme of several meetings.

No detailed mention need be made of the various verbal communications; it is sufficient to state that it is the custom of each member to provide at each meeting material illustrative of his own particular studies.

Mr. T. Chalkley Palmer continues his investigations of the movement of diatoms first noticed by Adams, in 1798, in an "*infusorium novum*," which "*moved either end foremost*," and which still mysteriously baffles the most patient observation. Mr. F. J. Keeley's demonstrations of microscopical technique have been of special interest.

The following officers have been elected for the year 1913:

Director	J. Cheston Morris, M.D.
Vice-Director	T. Chalkley Palmer.
Treasurer	Thomas S. Stewart, M.D.
Recorder	Charles S. Boyer.
Conservator	Frank J. Keeley.
Corresponding Secretary	Silas L. Schumo.

CHARLES S. BOYER,
Recorder.

ENTOMOLOGICAL SECTION.

This spring the insect collections were transferred from the temporary quarters in the bird gallery to the six rooms now occupied, and the first meeting in the new location was held on June 10. The work went on while the bird gallery was occupied, but the cabinets were so crowded together that work was done under very unfavorable conditions. The task of moving a million insects was one of very considerable magnitude, but was accomplished without damage to any of the specimens.

During the Centenary of the Academy a large part of the collection of exotic Lepidoptera was placed on exhibition in the room formerly occupied by the library and attracted much attention and interest. During the year 6,858 specimens have been received, either by gift, exchange or purchase, and a considerable proportion of these have been mounted and incorporated into the collections.

Twenty-four Brock tins and one hundred large glass-covered cases have been purchased by the Academy. It seems to be the opinion of those persons best qualified to judge, that this style of box is the best so far devised, and it is considered desirable to adopt it for all the orders of insects. After the collections were transferred to the

rooms now occupied, a general survey was made of the collection and additional untrustworthy boxes removed. Many boxes were treated with melted naphthalin. This was done wherever infestation was found. In the Lepidoptera the rearrangement of the micro-moths has been completed, although there are still some specimens awaiting identification. The genus Ornithoptera has been rearranged in its entirety. Additional cabinet space is needed for the exotic collection.

The collection of American diurnal Lepidoptera is in excellent condition and material is constantly being added.

Mr. E. T. Cresson has numbered and listed all the types of his species in the order Hymenoptera preparatory to publishing them.

A number of species have been added to the collection of Hemiptera and some material has been determined.

The exotic Coleoptera have been partially rearranged. The families have been labelled and material incorporated.

The North American collection, well into the family Carabidæ, and some of the smaller families which were badly crowded have also been rearranged. Many species, with accurate data, have been added to the collection and the duplicates put in order under family labels.

In the Diptera there has been considerable rearrangement; material has been added and species named.

Dr. Philip P. Calvert has continued his charge of the collection of Odonata and the work accomplished is credited to him. It is hoped ere long to obtain enough of the new type of boxes to provide for this important collection. The arrangement of the studied exotic series of Orthoptera, as well as a similar revision of the North American series, was completed during the year. The previously unarranged series of the same collection has also been completed. At the present time, as far as studied, the Orthoptera collections are well arranged and readily accessible, but during the coming year the exotic series will need considerable extension, owing to large additions to that series which will have to be installed. Mr. Morgan Hebard has deposited his entire collection of Orthoptera, including the Bruner North American types, in the Academy building, thus making the collections of the order in one room in the Academy the most extensive in America.

During the year the most important additions received have been the series retained by the Academy from the Mecklenburg Central African collection; a series from Venezuela purchased by the Academy;

another from Para, Brazil, also purchased; and an interesting collection from Java, received for identification. There has also been received for determination, and of which the Academy receives a set, several collections totalling over three thousand specimens from East Africa from the Berlin Museum, a series from Mexico from the Field Museum, several from the American Museum of Natural History from the same country, and a very extensive collection from the Transvaal Museum.

Mr. Hebard has worked during a considerable portion of the year at the Academy, often in conjunction with Mr. Rehn, frequently giving his attention to Academy material as well as his own collection. He has also maintained one, and for a time, two preparators who have worked on material, a large part of which will be given to the Academy after its study. Owing to the liberality of the same gentleman, Mr. Rehn was able to accompany him to the Florida Keys and Texas during the summer, a large series of the order being taken on the expedition, of which the Academy will receive a large proportion.

Two persons were elected Associates of the Section.

At a meeting held December 9 the following persons were elected officers to serve during the year 1913:

Director	Philip Laurent.
Vice-Director	Henry W. Wenzel.
Treasurer	Ezra T. Cresson.
Recorder	Henry Skinner.
Secretary	James A. G. Rehn.
Conservator	Henry Skinner.
Publication Committee	Ezra T. Cresson,
	Ezra T. Cresson, Jr.

Henry Skinner,
Recorder.

Botanical Section.

The alterations in the building made during the present year have materially increased the capacity of the herbarium, resulting in a number of changes in the arrangement of the collection. Twenty new metal cases have been added to the equipment. Most of these have been placed in the central room on the main floor to relieve the overcrowding in the two end rooms, the balance being used to accommodate the pteridophytes which have been rearranged in the central gallery room. The large seed case

has been transferred from the north to the central gallery room, the north room being used as a work room. The mounting of the flowering plants and ferns of the Albert Commons Herbarium has been completed.

The Conservator paid two visits to Bermuda during the year, from August 22 to September 21 and from November 30 to December 14, when important collections were made.

Ten thousand seven hundred and eighty-two sheets of plants have been added to the herbarium. Of these, 7,198, distributed through the general herbarium, have been secured by purchase, 352 by the Section. Other sources of supply were from Academy expeditions, 300; Arnold Arboretum, 292; United States National Museum, 385; in exchange and presented by individuals as follows: Dr. James Darrach, 2,000; Miss Caroline A. Boice, 2,000; Charles S. Wlliamson, 480; Francis W. Pennell, 443; Witmer Stone, 270; Henry A. Lang, 250; Edwin B. Bartram, 200; Dr. D. G. Metheny, 127; Harold W. Pretz, 28; Henry F. Michell Co., 27; Harold St. John, 21; E. G. Vanatta, 12; Silas L. Schumo, 6; Mrs. Joseph M. Fox and Miss Olivia Rodham, each 2; Dr. William L. Abbott, Dr. Curtin, and Rev. Mr. Baker, each 1. Three thousand five hundred and eighty-four sheets have been added to the local herbarium of the Philadelphia Botanical Club, being contributed principally by its members. Mr. Samuel S. Van Pelt has continued his valued services in the care of this division of the herbarium, and Mr. Bayard Long has also done much valuable work. The Philadelphia Botanical Club has held its monthly meetings in the Academy during the year as heretofore.

At the annual meeting of the Section the following were elected as the officers for the coming year.

Director	Benjamin H. Smith.
Vice-Director	Joseph Crawford.
Recorder	Charles S. Williamson.
Treasurer and Conservator	Stewardson Brown.

Respectfully submitted,

STEWARDSON BROWN,
Conservator.

MINERALOGICAL AND GEOLOGICAL SECTION.

The Section has held four meetings this year, with about the average attendance.

A communication was made by B. S. Lyman on the Formation

of Coal Beds; Dr. Thomas C. Brown read a paper on the Origin of the Early Paleozoic Sediments of Central Pennsylvania; and Mr. F. J. Keeley made a communication on Meteorites from Arizona. There were also shorter communications and various discussions.

There were six field excursions, with an average attendance of over 28. The parties visited: (1) Crystalline rocks near Neshaminy Creek, below the Falls, Bucks County; (2) Crystalline rocks near Unionville and Northbrook, Chester County; (3) The Aldham, Chester County, trap and the Cambrian Sandstone of North Valley Hill; (4) Crystalline rocks and their minerals between Avondale and Crum Lynne, Delaware County; (5) The Paleozoic rocks between Strafford, Chester County, and Bridgeport, Montgomery County; (6) Crystalline and Paleozoic rocks between Radnor, Delaware County, and Gulf Mills, Montgomery County.

Four new associate members were elected.

The following officers of the Section have been elected for the year 1913:

Director	Benjamin Smith Lyman.
Vice-Director	F. J. Keeley.
Recorder and Secretary	S. L. Schumo.
Treasurer	William B. Davis.
Conservator	George Vaux, Jr.

Respectfully submitted by order of the Section.

BENJAMIN SMITH LYMAN,
Director.

ORNITHOLOGICAL SECTION.

During the early part of the past year, while the alterations to the building were in progress, the ornithological collections were for the most part inaccessible for study. As soon, however, as the rooms had been renovated the cases containing the study series were moved back in place, thoroughly cleansed, and the entire collection examined and rearranged where specimens had been displaced in moving.

The permanent quarters now provided for the department permit of the arrangement of the collections to much better advantage than ever before, while the new skylights and electric-light facilities enable the student to readily consult any of the specimens. Many of the old unmounted specimens have been relaxed and made to

conform in appearance with the skins, which renders them more available for study and more easily cared for.

Mr. Charles J. Pennock, who was appointed November 5, 1912, as a voluntary special curator of the Oological collections, has already begun the rearrangement of the material and has outlined plans for its expansion. After the removal of the Entomological Department from the bird floor of the Museum, where it had occupied temporary quarters during the alterations, the exhibition cases were carefully examined and much mounted material which had been labelled and arranged for exhibit was systematically placed. Although only one or two specimens of most species are now exhibited and all types and most of the unique specimens have been withdrawn, it will be necessary still further to reduce the exhibit, as it is much overcrowded.

The local collection, established and increased from year to year by the Delaware Valley Ornithological Club, has been entirely rearranged, two large cases having been provided for the water birds and birds of prey. Many specimens which it has been impossible to exhibit previously have been mounted in groups with natural accessories, while the series of birds presented by the late Francis W. Rawle and others have been mounted with their respective nests, thus completing many of the older groups. The appearance and educational value of this collection has been thus greatly enhanced.

In the time not occupied by his duties as Curator, in general Museum work and in the arrangement of the bird collection, the Conservator has identified the entire collection of 1,548 birds obtained by Mr. S. N. Rhoads in Ecuador during 1911, which was acquired by the Academy early in the year. He has also identified the Venezuelan collection obtained by the Francis E. Bond expedition, and prepared reports on both for publication.

A careful study of the types of Gould's Australian birds has also been made in connection with the problems encountered by Mr. Gregory M. Mathews in the publication of his *Birds of Australia*. The results of this work are likewise prepared for publication, as well as the report on the Raptores of the Princeton Patagonian Expedition.

During the year, in addition to the Ecuador collection above referred to, the Academy has received an important gift of birds of West Africa from Mr. G. L. Bates, of Cameroons, the first accession from this region since the famous Du Chaillu collections; also numerous specimens for the local collection from the Delaware Valley Ornithological Club.

Thirty metal storage cases have been procured for the accommodation of the accessions.

The Delaware Valley Ornithological Club and the Pennsylvania Audubon Society have continued to hold their meetings at the Academy and have done much to stimulate ornithological study.

The Conservator would express his indebtedness to Mr. J. A. G. Rehn, who has catalogued all of the accessions, and to Messrs. Daniel J. Fay and Delos E. Culver, who have given valuable aid in the rearrangement of the collection, Mr. Culver having accomplished particularly satisfactory work in relaxing the old unmounted birds. To Mr. David McCadden, our taxidermist, is due much of the success in the improvement of the local collection.

The annual meeting of the Section was held on December 3, 1912, and the following officers were reëlected:

Director	Spencer Trotter, M.D.
Vice-Director	George Spencer Morris.
Recorder	Stewardson Brown.
Corresponding Secretary	William A. Shryock.
Treasurer and Conservator	Witmer Stone.

WITMER STONE,
Conservator.

The annual election of Officers, Councillors, and Members of the Committee on Accounts was held December 17, with the following result:

PRESIDENT	Samuel G. Dixon, M.D., LL.D.
VICE-PRESIDENTS	Edwin G. Conklin, Ph.D., Sc.D.
	John Cadwalader, A.M.
RECORDING SECRETARY	Edward J. Nolan, M.D.
CORRESPONDING SECRETARY	J. Percy Moore, Ph.D.
TREASURER	George Vaux, Jr.
LIBRARIAN	Edward J. Nolan, M.D.
CURATORS	Samuel G. Dixon, M.D., LL.D.,
	Henry A. Pilsbry, Sc.D.,
	Witmer Stone, A.M.,
	Henry Tucker, M.D.
COUNCILLORS TO SERVE THREE YEARS	Philip P. Calvert, Ph.D.,
	Thomas Biddle, M.D.,
	Frank J. Keeley,
	Thomas G. Ashton, M.D.

COMMITTEE ON ACCOUNTS.......Charles Morris,
Samuel N. Rhoads,
John G. Rothermel,
Thomas S. Stewart, M.D.,
Walter Horstmann.

COUNCIL FOR 1913.

Ex-Officio.—Samuel G. Dixon, M.D., LL.D., Edwin G. Conklin, Ph.D., John Cadwalader, A.M., Edward J. Nolan, M.D., J. Percy Moore, Ph.D., George Vaux, Jr., Henry A. Pilsbry, Sc.D., Witmer Stone, A.M., Henry Tucker, M.D.

To serve three years.—Philip P. Calvert, Ph.D., Thomas Biddle, M.D., Frank J. Keeley, Thomas G. Ashton, M.D.

To serve two years.—Charles B. Penrose, M.D., LL.D., Ph.D., Charles Morris, Spencer Trotter, M.D., William E. Hughes, M.D.

To serve one year.—Thomas H. Fenton, M.D., Edwin S. Dixon, Henry Skinner, M.D., Sc.D., Robert G. LeConte, M.D.

COUNCILLOR.......George Vaux, Jr.
CURATOR OF MOLLUSCA.......Henry A. Pilsbry, Sc.D.
CURATOR OF WILLIAM S. VAUX COLLECTIONS.......Frank J. Keeley.
CUSTODIAN OF ISAAC LEA COLLECTION.......Jos. Willcox.
ASSISTANT LIBRARIAN.......William J. Fox.
ASSISTANTS TO CURATORS.......Henry Skinner, M.D.,
Stewardson Brown,
J. Percy Moore, Ph.D.,
Edward G. Vanatta,
Henry W. Fowler,
James A. G. Rehn,
Ezra T. Cresson, Jr.
ASSISTANT IN LIBRARY.......Furman Sheppard Wilde.
AID IN ARCHÆOLOGY.......Harriet Newell Wardle.
AID IN HERBARIUM.......Ada Allen.
Taxidermist.......David N. McCadden.
Janitors.......Charles Clappier,
Daniel Heckler,
James Tague.
Jacob Aebley,
Adam E. Heckler.

STANDING COMMITTEES.

FINANCE.—John Cadwalader, A.M., E. S. Dixon, Effingham B. Morris, William D. Winsor, and the Treasurer.

PUBLICATIONS.—Henry Skinner, M.D., Sc.D., Witmer Stone, A.M., Henry A. Pilsbry, Sc.D., William J. Fox, Edward J. Nolan, M.D.

LIBRARY.—Thomas H. Fenton, M.D., George Vaux, Jr., Henry Tucker, M.D., Frank J. Keeley, Thomas Biddle, M.D.

INSTRUCTION AND LECTURES.—Henry A. Pilsbry, Sc.D., Charles Morris, Witmer Stone, A.M., Henry Tucker, M.D., George Spencer Morris.

COMMITTEE OF COUNCIL ON BY-LAWS.—Thomas Fenton, M.D., John Cadwalader, A.M., Charles B. Penrose, M.D., Witmer Stone, A.M.

ELECTIONS IN 1912.

MEMBERS.

January 16.—G. B. Heckel, Henry S. Pratt, Ph.D., Edwin B. Bartram.

February 20.—Frederick Ehrenfeld, Francis B. Bracken.

April 16.—Harold Peirce, John Ashhurst, Samuel C. Schmucker, Ph.D., William H. Newbold, Cecilia Baldwin McElroy, Seth Bunker Capp, Walter N. James, M.D., A. V. Morton, Harriet Newell Wardle, Philip F. Kelly, Hon. John M. Reynolds.

October 15.—Ernest Comly Dercum, Warren Mathews Foote.

November 19.—Horace E. Smith.

CORRESPONDENTS.

January 16.—Viktor Goldsmidt, of Heidelberg, Charles Haskins Townsend, Sc.D., of New York, Carlotta J. Maury, Ph.D., of New York, John C. Branner, of Stanford University, Cal.

ADDITIONS TO THE MUSEUM, 1912.

ETHNOLOGICAL AND ARCHÆOLOGICAL.

THOMAS BIDDLE, M.D. Specimen of mummified trophy head or "tsantsa," prepared by the Jibaros tribe of Ecuador.

MRS. E. D. COPE. Mexican grinding stone.

SAMUEL G. DIXON, M.D. Metlatl and metlapille, Mexico.

R. W. SHUFELDT, M.D. Human skeletal remains, Campeche, Yucatan.

MISS E. E. KEATING. Rattle and two figurines of terra cotta, Mexico (collected 1825–1829).

LUDWIG PFEIFFER, M.D. Ten casts of paleoliths from Taubach-Ehringsdorf, near Weimar, Germany.

CLARENCE B. MOORE. Numerous additions to the Clarence B. Moore Collection from Indian Mounds of the Southern States.

MAMMALS.

WM. L. ABBOTT, M.D., through Miss Gertrude Abbott. Collection of heads of African antelopes, Rhinoceros horns and tail.

CHARLES W. BECK. Several whale vertebræ, Beach Haven, N. J.

THOS. BIDDLE, M.D. Collection of mounted mammals: adult female and young Gorilla (*Gorilla gorilla*), young orang-utan (*Pongo pygmæus*), Koola-kamba (*Simia koolakamba*) with mounted skeleton, Rutledge's Monkey (*Pygathrix rutledgii*), Galla Colobus (*Colobus gallarum*) with skull, European Lemming (*Lemmus lemmus*), Duckbill (*Ornithorhynchus anatinus*) and os penis of Walrus (*Odobenus* sp.).

S. ROWLAND CALDWELL. Pair of Walrus tusks.

MRS. E. D. COPE. Plaster cast of Gorilla's head.

T. D. KEIM and H. W. FOWLER. Red Bat (*Lasiurus borealis*), Delaware.

H. L. MATHER, JR. Two Brown Bats (*Eptesicus fuscus*), Philadelphia.

D. G. METHENY, M.D. One shrew (*Blarina* sp.), Nova Scotia.

ROBERT MORRIS. Two Say's Bats (*Myotis subulatus*), Montgomery County, Pennsylvania.

PURCHASED. Otter (*Lutra canadensis*), Salem County, N. J. Prepared as skin and skull. Skin and skeleton of cow Bison (*Bison bison*). Collection of mammalian skins and skulls, British East Africa; several specimens for the local collection.

HENRY TUCKER, M.D. Brown Bat (*Eptesicus fuscus*), Philadelphia.

ZOOLOGICAL SOCIETY OF PHILADELPHIA. Prepared for mounting: Clouded Leopard (*Felis nebulosa*); Raccoon-like Dog (*Canis procyonoides*); Ruffed Lemur (*Lemur varius*). Prepared as skin and skull: Wolverene (*Gulo luscus*); Cape Hyrax (*Procavia capensis*); Variegated Capuchin (*Cebus variegatus*);

Mozambique Monkey (*Cercopithecus pygerythrus*); Schmidt's Monkey (*Cercopithecus schmidti*). Prepared as skin: Red Kangaroo (*Macropus rufus*); Gray Lagothrix (*Lagothrix lagothrica*). Prepared as skin and skeleton: Wombat (*Phascolomys mitchelli*). Prepared as skeleton: Collared Peccary (*Tayassu tajacu*); Wombat (*Phascolomys mitchelli*). Prepared as alcoholic: Very young Northern Warthog (*Phacochœrus africanus*).

Birds.

Wm. L. Abbott, M.D., through Miss Gertrude Abbott. Three cases of mounted North American birds.

Gen. George Anderson. Two Nutmeg Pigeons (*Myristricivora*), Philippines.

George L. Bates. Twelve skins of birds, Bitje, Cameroons, W. Africa.

Conrad Behrens, M.D. Barn Owl (*Aluco pratincola*), Cape May Point, N. J.

Miss Lizzie Brader. Abnormal Chipping Sparrow (*Spizella socialis*).

Harry Chambers. One Starling (*Sturnus vulgaris*), Moorestown, N. J.

Alfred M. Collins and E. Marshall Scull. Twenty bird skins, British East Africa.

W. B. Crispin. Red-tailed Hawk (*Buteo borealis*), Salem, N. J.

William B. Davis. Little Auk (*Alle alle*), Ocean City, N. J.

Delaware Valley Ornithological Club. Several local bird nests and eggs.

W. N. Ely. Saw-whet Owl (*Cryptoglaux acadicus*).

W. L. Ewing, Jr. Bald Eagle (*Haliæetus leucocephalus*) and Barred Owl (*Strix varia*), Cape May, N. J.

Edward N. Fox. Two specimens of Wilson's Tern (*Sterna hirundo*), Sea Isle City, N. J.

Wm. E. Hughes, M.D. Two White-winged Scoters (*Oidemia deglandi*), Maryland.

Ida A. Keller, Ph.D. One Starling (*Sturnus vulgaris*), Salem, N. J.

Philip Laurent. Franklin's Gull (*Larus franklini*), Philadelphia, Pa.

Dr. Charles B. Penrose. Little Auk (*Alle alle*), Virginia Beach, Va.

F. H. Peppelman. Four-legged Chicken.

Purchased. Two Red-breasted Mergansers (*Mergus serrator*), Sea Isle City, N. J. Series of neotropical birds.

Miss Belle Vansant. Three Starlings (*Sturnus vulgaris*), Newtown, Pa.

Zoological Society of Philadelphia. Prepared as skin: Crowned Pigeon (*Goura victoria*); Eagle (*Aquila* sp.). Prepared as skeleton: Ground Hornbill (*Bucorax abyssinicus*); Concave-casqued Hornbill (*Dichoceros bicornis*); Black-necked Swan (*Sthenelides melanocoryphus*). Prepared as skull: Black-necked Swan (*Sthenelides melanocoryphus*).

Reptiles and Amphibians.

C. C. Abbott, M.D. House Snake, Trenton, N. J.

O. E. Baynard. Five jars of reptiles, Florida.

Charles W. Beck. Several bones of sea turtle (*Caretta caretta*), Beach Haven, N. J.

THOMAS BIDDLE, M.D. Specimen of Cobra.

C. H. CONNER. Green Snake (*Opheodrys*), Burlington Co., N. J.

H. W. FOWLER. *Rana* and *Hemidactylum*, Bucks County, Pa. Fence Lizard (*Sceloporus undulatus*), Denton, Md.

HENRY FOX, BAYARD LONG, and STEWARDSON BROWN. Copperhead (*Agkistrodon contortrix*), Zieglerville, Pa.

PHILIP LAURENT. Green Snake (*Opheodrys æstivus*), Iona, N. J.

BAYARD LONG. Three frogs, Prince Edward Island and Magdalen Islands, Canada.

H. L. MATHER, JR. Jar of *Spelerpes ruber*, Philadelphia.

H. A. PILSBRY. Mud Turtle (*Aromochelys odoratus*) and Frogs (*Rana sylvatica* and *clamata*), New Jersey.

WM. QUIGLEY. Salamander, California.

EVAN RHOADS. Water-snake (*Natrix sipedon*) with seventy-four young, Newton Creek, N. J.

SAMUEL C. SCOVILLE, JR. Timber Rattlesnake (*Crotalus horridus*), Connecticut.

F. TAPPAN. Several frogs (*Pseudacris triseriatus*), Minnesota.

ZOOLOGICAL SOCIETY OF PHILADELPHIA. Alligator Snapping-turtle (*Macroclemmys temminckii*). Prepared as skeleton: Mastigure.

FISHES.

ACADEMY EXPEDITION [H. W. FOWLER]. One keg and seven jars of fishes, Chincoteague, Va.

WILLIAM N. ALLEN. Saw of Saw-fish.

O. E. BAYNARD. One jar of fishes, Florida.

R. E. BROWN. Collection of fishes, Cape May, N. J.

HORACE HADLEY BURTON. Roe and milt of hermaphroditic shad.

CARNEGIE MUSEUM (IN EXCHANGE). Collection of eleven species of South American fishes.

WM. B. DAVIS and H. W. FOWLER. Four jars of fishes, Great Bay, N. J.

H. W. FOWLER. Lamprey (*Petromyzon marinus*), Tullytown, Pa. Five lots of fishes, Pennsylvania, New Jersey and Maryland.

W. J. FOX. Hair-tail (*Trichiurus lepturus*), Green Gar (*Tylosurus raphidoma*), Crab-eater (*Rachycentron canadus*) and Sea Catfish (*Felichthys marinus*), Sea Isle City, N. J.

JULIUS HURTER. Collection of fishes, Missouri.

WM. T. INNES, JR. Three lots of fishes, Illinois. Three fishes, California.

MASTER CHARLES J. JONES. Burr fish (*Chilomycteris schoepfi*), Atlantic City, N. J.

F. J. KEELEY. Pipe fish (*Syngnathus fuscus*), Egg Harbor Bay, N. J. Bat fish (*Ogcocephalus radiatus*), Indian River, Fla.

BAYARD LONG. Two lots of fishes, Long Beach, N. J. Collection of small fishes, Prince Edward Island and Magdalen Islands, Canada.

H. L. MATHER, JR. Two jars of fishes, Pennsylvania and Maryland. Brook Trout (*Salvelinus fontinalis*), Monroe County, Pa.

WM. E. MEEHAN. Trout (*Salvelinus fontinalis*), Pike (*Esox americanus*) and Calico Bass (*Pomoxis sparoides*), Fairmount Aquarium.

D. G. METHENY, M.D. Two kegs of fishes, Nova Scotia.

F. M. Meyers and H. W. Fowler. Three jars of fishes, Bethlehem, Pa.

David N. McCadden. Lizard fish (*Synodus fœtens*), Ocean City, N. J.

Pennsylvania State Fish Commission, through the Hon. N. R. Buller, Commissioner. Two collections of fishes, Erie, Pa.

Dr. R. J. Phillips. Small collection of fishes, Corson's Inlet, N. J.

Purchased. Collection of British Guiana fishes.

Joseph Redl. Flying fish (*Exocœtus* sp.), Madeira.

Joseph V. E. Titus. Collection of Trout (*Salvelinus marstoni*), Canada.

R. W. Wehrle. Three jars of fishes, Indiana County, Pa.

Recent Mollusca.

J. Aebly. *Viviparus malleatus* Rve. and *Limax maximus* L.

Clarence L. Aman. Eight species from Cuba.

C. A. Baker. Ten species from Florida.

C. F. Baker. Ten species from Nicaragua; four from Colombia; one from Alabama.

F. C. Baker. *Planorbis campanulatus* Say and *Planorbis campanulatus smithii* Bkr. (cotypes).

Dr. Fred Baker. *Tomigerus lævis* Iher. from Brazil.

H. B. Baker. Thirty-four species from Michigan.

Edwin B. Bartram. Eight species from Newfoundland.

M. G. Becker. Six species from California, Iowa, Kansas and Illinois.

Horace J. Binney, Jr. *Cypræa erosa carmen* Smith (cotype).

Henry J. Boekelman. *Poecilozonites circumfirmatus* Redf. from Bermuda.

Caroline A. Boice. Six trays of shells.

Amos P. Brown. Nine species from Maine and four from Colombia.

R. E. Brown. Fulgur egg-case from New Jersey.

George H. Clapp. Two species from Cuba, four from Bahamas, two from Florida.

Wm. F. Clapp. Eight species from Massachussets, two from Vermont, one from Maine.

W. F. Clapp and R. K. Smith. *Carychium minimum* Müll. from Massachusetts.

T. D. A. Cockerell. Ten species from Guatemala.

M. Connolly. Eighteen species from South Africa (including topotypes).

Delos E. Culver. Twenty species from Pennsylvania.

William H. Dall, Ph.D. *Planorbis antrosus percarinatus* Wkr. from New Hampshire.

C. S. Dolley, M.D. Sixteen species from Mexico.

Henry Edson. *Helminthoglypta d. cuestana* Eds. from California (types).

S. M. Edwards. Four species from Ohio, one from Oregon and one from Colorado.

Rev. W. H. Fluck. *Pachychilus largillierti* Phil. from Nicaragua.

Henry W. Fowler. Forty-two species from New Jersey, Pennsylvania, Delaware, Maryland and Virginia.

William J. Fox. *Polygyra albolabris maritima* Pils. from New Jersey.

L. S. Frierson. *Unio Jacksoniensis* Fr. (types) from Mississippi, *Quadrula trapezoides pentaganoides* Fr. and *Quadrula heros* Say from Louisiana.

PROF. H. GARMAN. *Physa sayi* Tapp. and *Goniobasis brevispira* Anth. from Kentucky.

G. M. GREENE. Eight species from New Jersey and Pennsylvania.

J. B. HATCHER. Twelve species from Argentine Republic and one from Patagonia.

MISS CLARA DE HAVEN. *Turbo a. margaritaceus* L.

ARTHUR HAYCOCK. Seven species from Bermuda.

H. HEATH. *Tivela stultorum* Mawe from California.

MORGAN HEBARD. Five species from Bermuda, twenty from Florida (including types) and four from Texas (including types).

J. B. HENDERSON. Two species from Florida.

JUNIUS HENDERSON. Nineteen species from Colorado and Wyoming.

A. A. HINKLEY. *Anculosa* n. sp. from Alabama.

E. J. H. HOWELL. *Harpa crassa* Mörch, *Turbo marmorata* L.

H. v. IHRING. Cotypes of three species of *Oxychona* from Brazil.

H. I. INNES, Jr. *Physa gyrina* Say, *Sphærium solidulume* Prime and *Sphærium striatinum* Lam. from Illinois.

S. JACOB. *Vivipara contectoides* from Fairmount Park.

H. A. KAEBER. *Pyramidula a. fergusoni* Bld. and *Zonitoides arborea* Say from Pennsylvania.

F. J. KEELEY. Four species from Florida.

BAYARD LONG. One hundred and ninety-two trays from Pennsylvania, twenty-eight from Delaware, fifty-five from New Jersey, two hundred and fifty-six from Canada and one from Porto Rico.

HERBERT N. LOWE. *Epiphragmophora veitchii* D. from Lower California.

J. G. MALONE. Eight species from Lower California.

BRUCE MARTIN. *Ariolimax columbianus* Gld. from Calif.

H. L. MATHER. *Viviparus contectoides* Binn. from Philadelphia.

W. G. MAZYCK. Four species from South Carolina.

D. G. METHENY, M.D. *Purpura lapillus* L., *Acmæa testudinalis* Mill. and *Littorina littorea* L. from Nova Scotia.

G. W. H. MEYER. Five species of shells.

CLARENCE B. MOORE. Five species from Florida, three from Arkansas, twenty from Louisiana.

L. H. McNEILL. *Praticolella mobiliana* Lea from Alabama.

W. H. OVER. Three species from Michigan, two from South Dakota.

GEORGE W. PEPPER. *Cerion pepperi* Bartch from Andros Islands, Bahamas; *Leptinaria sallesana* Pfr. from Dominican Republic; *Eulota similaris hongkongenis* from Batavia, Java.

ALICE PILSBRY. Ten species from Michigan.

H. A. PILSBRY. Three species from Florida, seven from Cuba and thirty-four trays from New Jersey.

HAROLD W. PRETZ. *Gastrodonta suppressa* Say from Pennsylvania.

CHARLES T. RAMSDEN. Six species from Spain.

MRS. F. W. RAWLE. *Acmæa* from Maine; *Crepidula fornicata* L. and *Crepidula plana* Say from Massachusetts.

S. RAYMOND ROBERTS. Three species from Pennsylvania, three from Marthas Vineyard.

A. D. ROBERTSON. Sixty-two species from Canada.

ROBERT ROSENBAUM. *Littorina Littoria* L. from Massachusetts.

F. A. SAMSON. Sixteen species from Missouri.

S. L. SCHUMO. *Circulus* sp. from British Honduras.

PROF. BURNETT SMITH. Eighty species from New York, fourteen from California.

HERBERT H. SMITH. Five species from Alabama, one from Cuba.

STATE BOARD OF HEALTH. *Agriolimax campestris* Binn. from Missouri.

V. STERKI, M.D. Seven species from Indiana, Ohio, Tennessee and North Carolina.

WITMER STONE. Sixteen species from Maryland, one from Pennsylvania, five from Wisconsin, eight from Minnesota.

C. DE LA TORRE. Fourteen species from Cuba (including some types).

U. S. FISH COMMISSION. Four species.

UNIVERSITY OF MICHIGAN. *Amphidromus chloris* Rve. from Basilan and Tamboanga, P. I.

UNIVERSITY OF WISCONSIN. Eighteen species from Molokai (including types).

EDWARD G. VANATTA. Twelve species from Pennsylvania, twenty-eight from New York, three from Maryland.

T. VAN HYNING. *Physa integra* Hald., *Succinea avara* Say and *Succinea concordialis* Gld. from Iowa.

BRYANT WALKER. Thirteen species from Michigan, Texas (including paratypes), Alabama, Illinois (cotypes) and Mexico.

HENRY A. WENZEL. Eighteen species from Texas.

JOSEPH WILLCOX. *Vermetus* from Florida.

C. S. WILLIAMSON. Five species from Ontario, three from Michigan.

HELEN WINCHESTER. *Anomia simplex* from Ocean View.

HENRY W. WINKLEY. One species from Maine (types), seven from Massachusetts, one from Connecticut.

H. T. WOLF. Twelve species from Florida.

W. H. ZEHRING. *Unio roanokensis northhamptonensis* Lea from Pennsylvania, and pearl from the same.

BY PURCHASE. Collection of East Indian and Indo-Chinese marine and land shells.

INSECTS.

BERLIN MUSEUM. Four hundred and twenty-five Orthoptera, Central Africa.

J. C. BRADLEY. Three Hymenoptera, New York; one Heteropteron, Georgia, one *Cephus pygomæa*.

A. P. BROWN. Three ants, Pennsylvania.

H. S. BRYANT. Twenty-five insects, Labrador.

P. P. CALVERT. Twenty-six Diptera, Africa; two Cicada, New Jersey.

E. CHAKOUR. Sixty-one Orthoptera, Egypt.

T. D. A. COCKERELL. Thirty-two Hymenoptera, Guatemala and Australia; eighty-seven Hymenoptera, United States.

A. N. COLLINS and A. S. SCULL. Forty-one Lepidoptera, Central Africa.

E. T. CRESSON, JR. One hundred and eight insects, United States.

V. A. E. DAECKE. Stenophis work, Harrisburg, Pa.; six *Ogrilus lecontei*, Lemoyne, Pa.

HENRY FOX. *Xiphidium sparteinæ* (type), *X. nigropleuriodes* (type), three *X. sparteinæ*.

W. J. GERHARD. Four Lepidoptera, Chicago.

S. M. GREENE. Two hundred and forty-one Coleoptera, United States.

GERMAN ENTOMOLOGICAL MUSEUM. Thirteen Orthoptera.

F. HAIMBACH. *Tetragoneura spinosa*, New Jersey; one hundred and fifty-eight *Microlepidoptera*, Pennsylvania and New Jersey.

M. HEBARD. Two hundred and six Lepidoptera (in plaster casts), Mundus; one hundred and twenty-five Lepidoptera, Thomasville, Georgia; ten *Oncideres putator*, Arizona; five moths, Georgia; thirteen *Papilios*, Georgia and Florida; seventy-six Orthoptera, United States; five insects, Florida; four hundred and thirty-seven Orthoptera, Southern Florida; twenty Orthoptera, North America; thirty-eight Hymenoptera, thirty-three Diptera, two hundred and twenty-five Coleoptera, Hebard Academy Expedition; four hundred and fifty Coleoptera, North Borneo; two hundred and sixty insects, United States; sixty-three Lepidoptera, United States; seventeen Odonoptera, twenty-one Hemiptera.

EDWARD JACOBSON. Thirty-four Orthoptera, Java.

UNIVERSITY OF KANSAS. Three Orthoptera.

H. KARNY. One hundred and seventy-nine Orthoptera, Southwestern Africa; Soudan, Southeastern Europe, Exchange.

H. NEWCOMB. *Lycæra neurora*, Mount Wilson, California.

R. ONION. One Pepsis, Texas.

R. F. Pearsall. Thirty-six Geometridæ, United States.

PURCHASED. One hundred and twenty-three Orthoptera, Cosmos Islands; five hundred and ninety Orthoptera, Congo, Peru, Cameroons; two hundred and eighty-six Orthoptera, four hundred and seventy Lepidoptera, Costa Rica.

C. F. RAMSDEN. *Mesosemia ramsdeni* (type and allotype), Cuba.

H. SKINNER. Fifty-three insects, Ardmore, Pennsylvania.

U. S. NATIONAL MUSEUM. Twenty-two Orthoptera.

W. STONE. One thousand three hundred and fifty-four insects, Minnesota and Wisconsin.

H. W. WENZEL. Two hundred and ninety Coleoptera, Texas.

C. S. WILLIAMSON. Ten Lepidoptera, Fort William, Canada.

OTHER INVERTEBRATES.

R. E. BROWN. Collection of crustacea, Cape May, N. J.

H. W. FOWLER. Five lots of crustacea and myriopoda, Pennsylvania, New Jersey and Maryland.

BAYARD LONG. Several lots of crustacea, Long Beach, N. J.

H. L. MATHER, JR. Small lot of local crustacea.

CHARLES B. PENROSE, M.D. *Moira atropos*, Virginia Beach, Va.

R. J. PHILLIPS, M.D. Box crab (*Calappa*), Corson's Inlet, N. J.

H. A. PILSBRY. Collection of crustacea, Cuba.

MRS. F. W. RAWLE. Collection of New England Invertebrates.

MRS. ALBERT SULLIVAN. Collection of corals.

E. G. VANATTA. Vial of isopods and lot of barnacles, Maryland and Pennsylvania.

MISS HELEN WINCHESTER. Barnacle (*Balanus*), Ocean View, Va.

Vertebrate Fossils.

Mrs. E. D. Cope. Fossil bones.

Purchased. Eight trays of Syrian Cretaceous fishes.

Mrs. L. Poole. Collection of fossil sharks' teeth, Trappe, Md.

Rev. Leander T. Chamberlain. *Carcharodon polygurus* Mort.; *Galeocerdo aduncus* Ag.

Invertebrate Fossils.

T. H. Aldrich. Four species of Pliocene shells, Glenrose, Texas.

Clarence L. Aman. Eight species of shells from clay deposit, Cuba.

R. O. Crawford. Fossil coral (*Synaptophyllum*), Montana.

Bayard Long. Fossil impressions, Monroe County, Pa.

Herbert B. and Emily Shonk. Specimen of coal fossil, Plymouth, Pa.

Joseph Willcox. Seventeen trays of Eocene fossils, Wilmington, N. C.

The following species of White Beach Oligocene fossils were added to the Isaac Lea Collection through the liberality of the Rev. Leander T. Chamberlain.

Conus planiceps Heilpr.; *Conus*, sp. undet.; *Turbinella valida* Sowb.; *Vasum haitense engonatum* Dall; *Oliva cylindrica* Sowb.; *Marginella*, sp. undet.; *Orthaulax pugnax* Heilpr.; *Malea ringens* Val.; *Cypræa willcoxii* Dall; *Cypræa*, sp. undet.; *Polinices duplicatus* Say; *Crucibulum auricula chipolanum* Dall; *Turritella tampæ* Dall; *Turritella tornata* Guppy; *Serpulorbis ballista* Dall; *Calliostoma*, sp. undet.; *Arca marylandica* Conr.; *Arca occidentalis* Phil.; *Arca*, three spp. undet.; *Glycimeris subovata plagia* Dall; *Pecten magnificus* Sowb.; *Pecten*, sp. undet.; *Ostrea*, two undet. sp.; *Mytilus aquila* Dall (?); *Spondylus*, sp. undet.; *Plicatula densata* Conr.; *Chama*, sp. undet.; *Chama macerophylla* Gmel.; *Cardium*, sp. undet.; *Lucina pennsylvanica* L.; *Lithophaga*, sp. undet.; *Crassatellites*, three undet. sp.; *Venericardia hadra* Dall; *Cardita recta* Conr.; *Chione latilirata* Conr.; *Chione*, sp. undet.; *Venus*, sp. undet.

Plants, Etc.

W. L. Abbott, M.D. Fruit of *Lodoicea callipyge*.

Arnold Arboretum. Two hundred and ninety-two specimens (exchange).

Charles C. Bachman. Sixty-four specimens.

Rev. Mr. Baker. *Phoradendron* sp.

Edwin B. Bartram. Three hundred and eighty-seven specimens.

George W. Bassett. Four hundred and forty-two specimens.

Bermuda Expedition. Three hundred specimens.

Miss Caroline A. Boice. Two thousand specimens.

Botanical Section. Three hundred and fifty-two specimens (purchased).

O. H. Brown. Two hundred and forty-eight specimens.

Stewardson Brown. Seven specimens.

D. E. Culver. One specimen.

Roland G. Curtin, M.D. *Sonchus arvensis*.

James Darrach, M.D. Two thousand specimens.

John W. Eckfeldt, M.D. *Aster amethystinus*, *Geranium sibericum*.

William Findlay. Sixty-one specimens.

Henry Fox, Ph.D. Four specimens.

Mrs. Joseph M. Fox. *Dryopteris spinulosa*, *D. cristata*.

J. H. Grove. Twenty-four specimens.

D. Hamm. Eighty-six specimens.

C. H. Jennings. Collection of sections of native trees of the Alleghanies, Garrett County, Md.

Miss Keeney. Two specimens *Geranium sibericum.*

Henry A. Lang. Two hundred and fifty specimens, Jamaica and Florida.

Bayard Long. One thousand five hundred and fifty-nine specimens.

E. S. Mattern. Two specimens.

W. Mattern. *Lacinaria squarrosa.*

D. G. Metheny, M.D. One hundred and twenty-seven specimens, Nova Scotia.

Henry F. Michell Co. Twenty-seven specimens of weeds.

New York Botanical Garden. One hundred Coraloid and other marine Algæ.

Francis W. Pennell. Five hundred and fifty-four specimens.

Mrs. J. E. Peters. Two specimens.

Harold W. Pretz. Four hundred and thirteen specimens.

J. A. G. Rehn and Morgan Hebard. Forty specimens.

Miss Olivia Rodham. *Flaveria linearis, Sauroglossum chranichoides.*

Wm. H. Roper. *Eryngium aquaticum.*

Mr. Ruth. *Rumex crispus.*

Harold St. John. Twenty-one specimens.

Silas L. Schumo. Six ferns.

Witmer Stone. Two hundred and seventy-three specimens.

United States National Museum. Three hundred and eighty-five specimens.

Harry W. Stout. Wood from Bear Valley Colliery, Dauphin County, Pa.

E. G. Vanatta. Twelve specimens.

Charles S. Williamson. Four hundred and eighty-one specimens, Newfoundland and Labrador.

Minerals.

John Heebner. Collection of copper and other minerals, Calumet Mine, Michigan, Montana, etc.

C. Henry Roney. Collection of minerals.

S. Raymond Roberts. Specimens of varicolored clay, Gay Head, Mass.

Mr. Albert Sullivan. Collection of minerals.

Wm. S. Vaux Collection (purchased). Eleven specimens.

INDEX TO GENERA, SPECIES, ETC., DESCRIBED AND REFERRED TO IN THE PROCEEDINGS FOR 1912.

Species described as new are indicated by heavy-faced, synonyms by italic numerals.

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BROWN AND PILSBRY. FOSSILS FROM WILMINGTON, N. C.

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WHERRY: SUN-CRACKS AND RINGING ROCKS.

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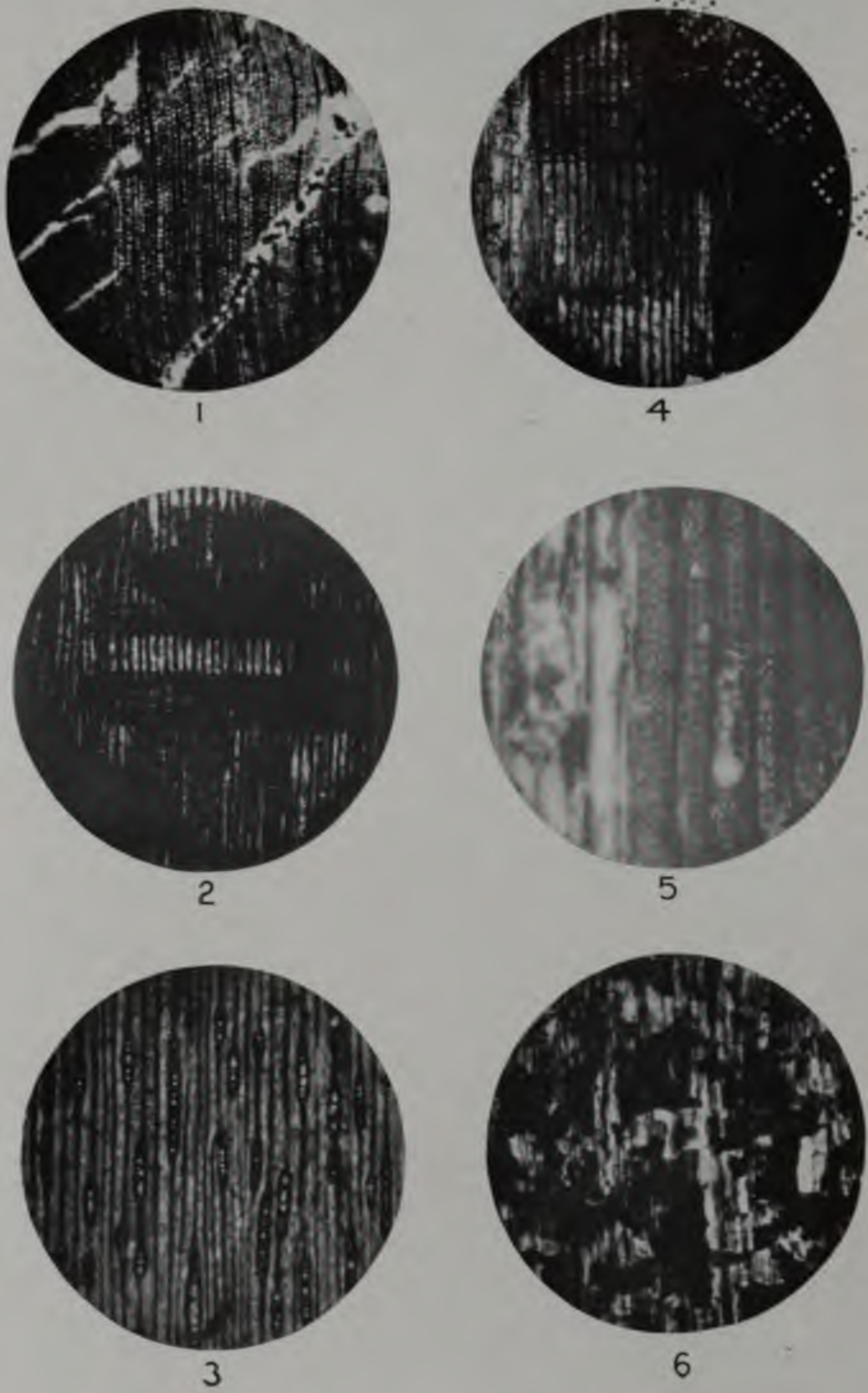
WHERRY: SILICIFIED WOOD.



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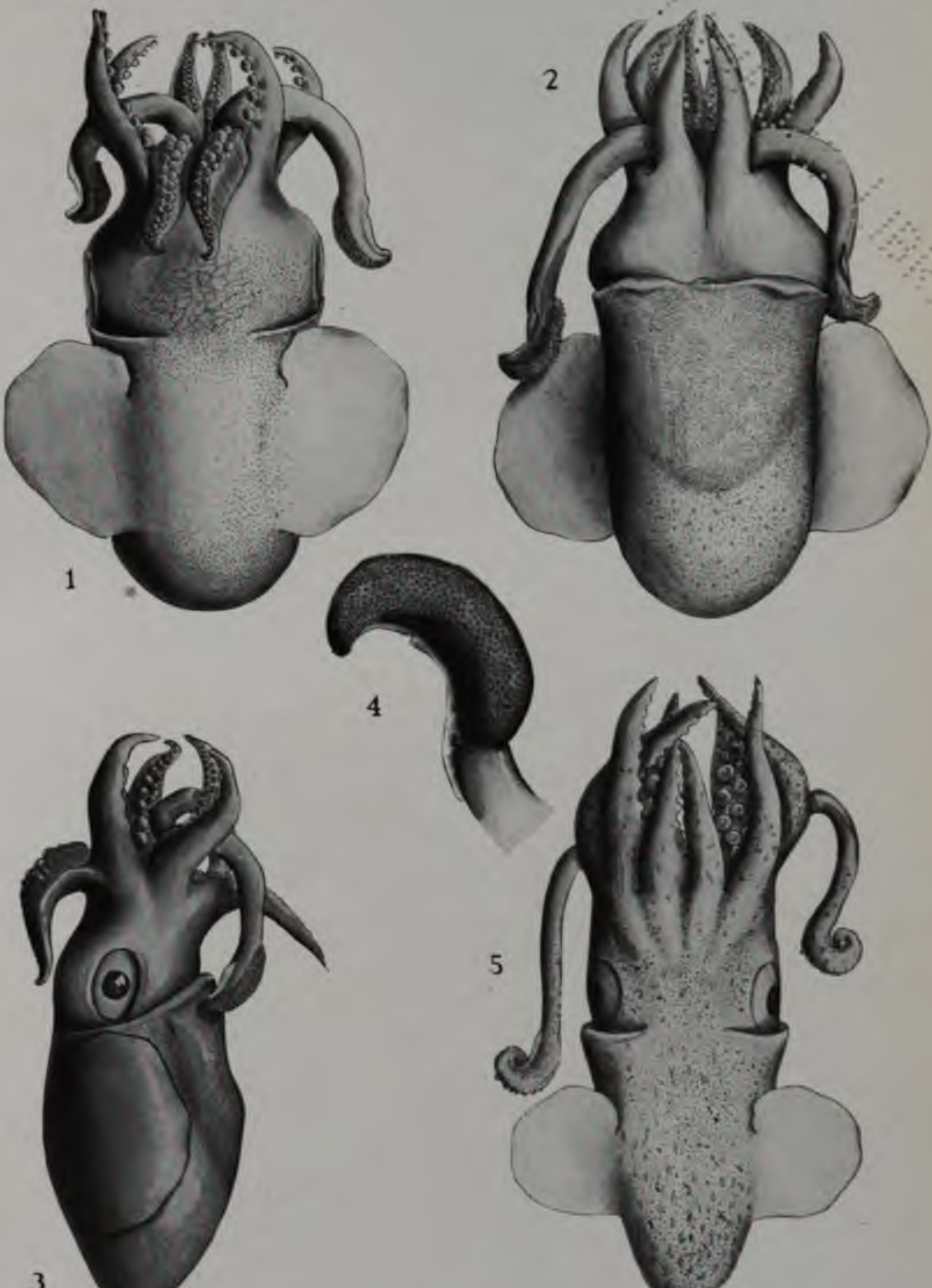
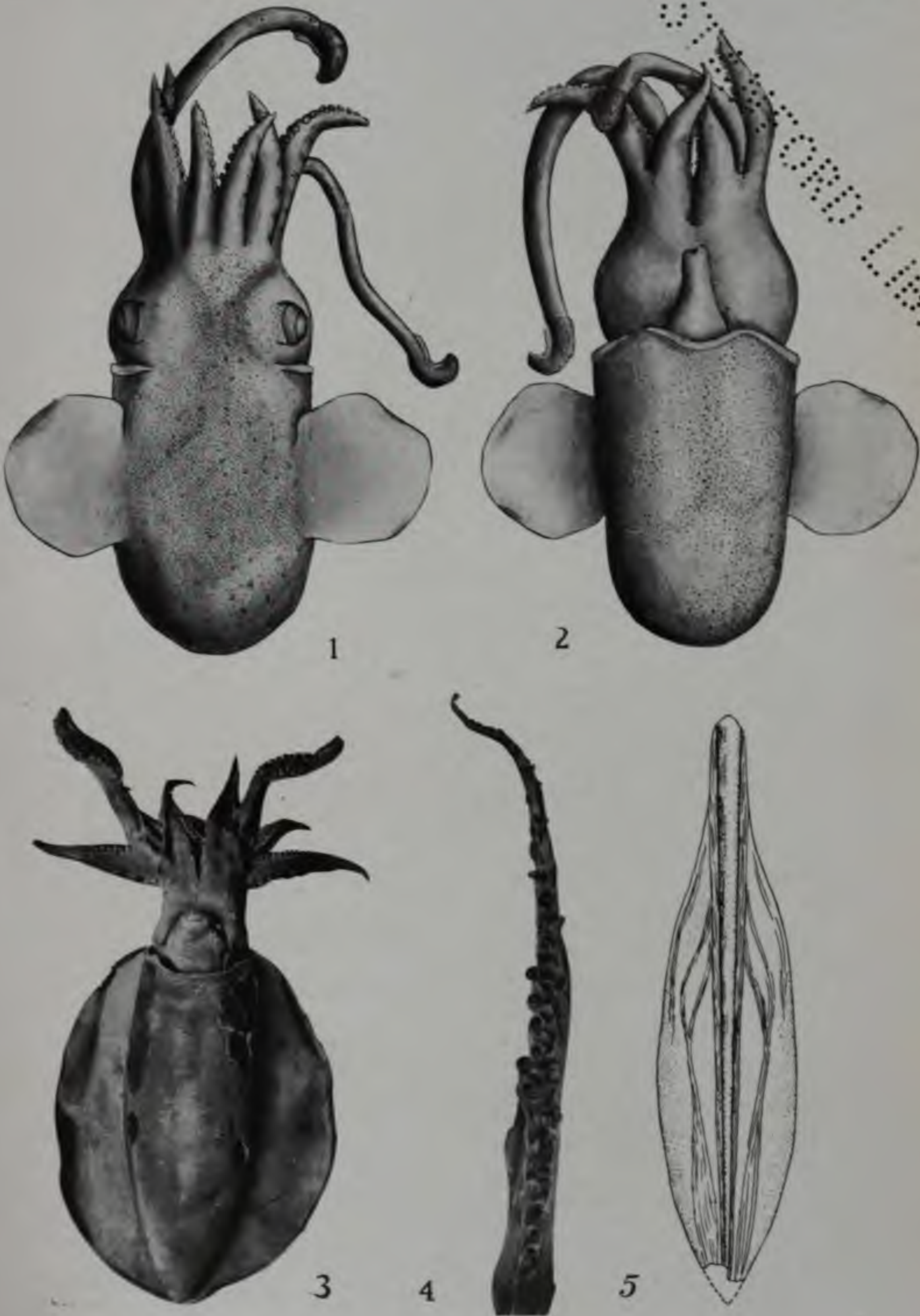


BERRY: JAPANESE CEPHALOPODA.



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BERRY: JAPANESE CEPHALOPODA.

BURNETT SMITH: CORAL BEDS IN THE HAMILTON SHALE.

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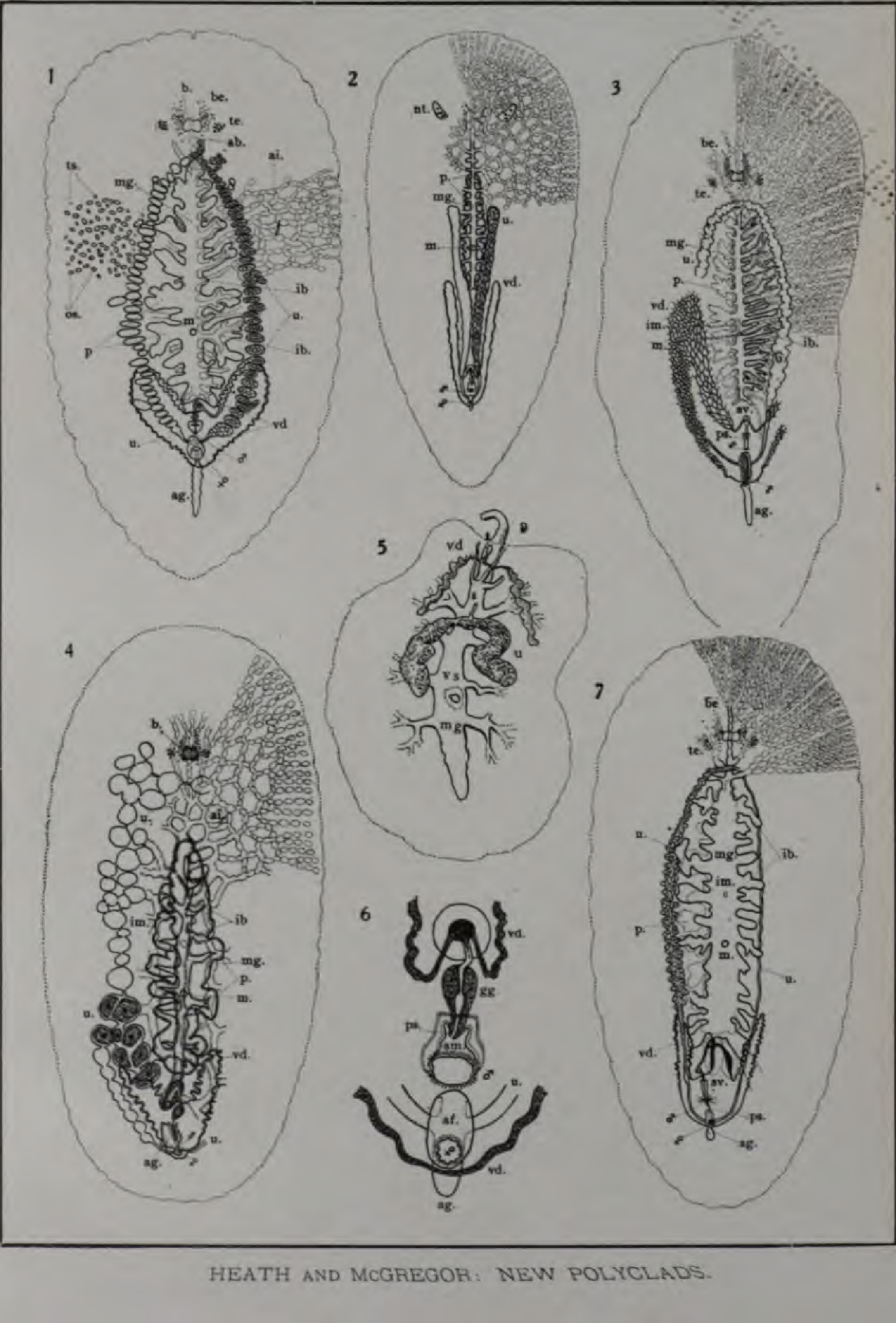
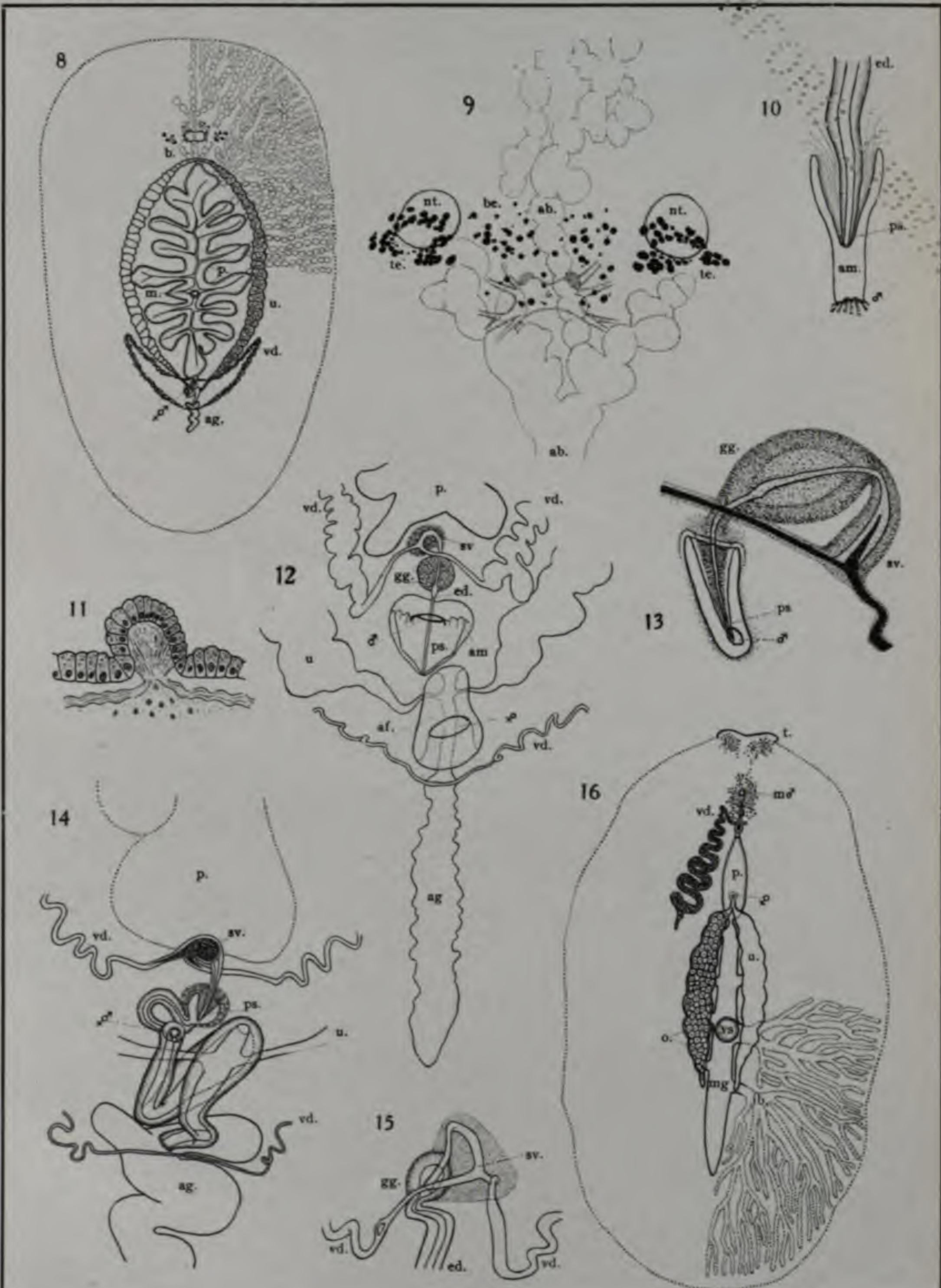


HEATH AND McGREGOR: NEW POLYCLADS.



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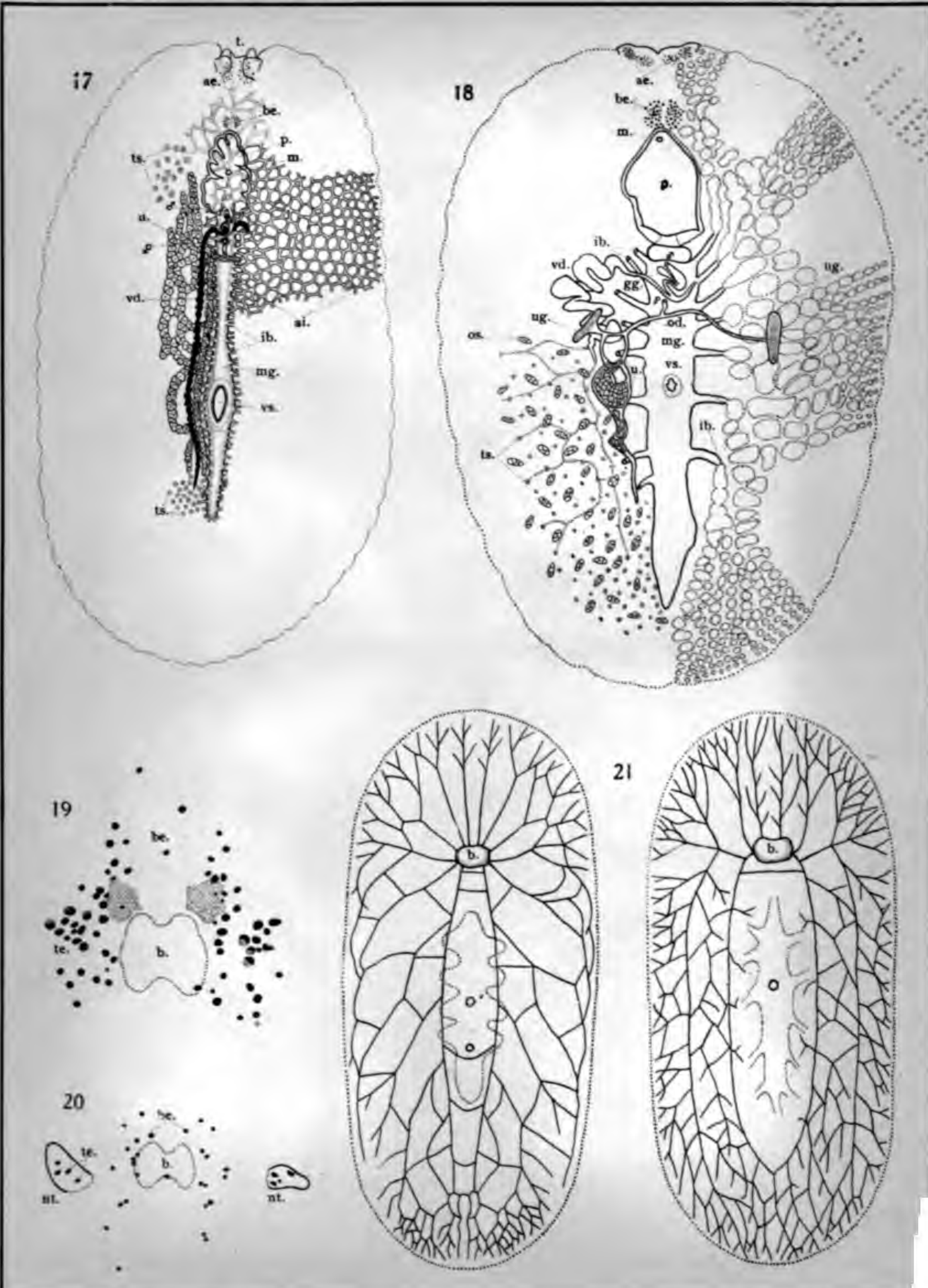

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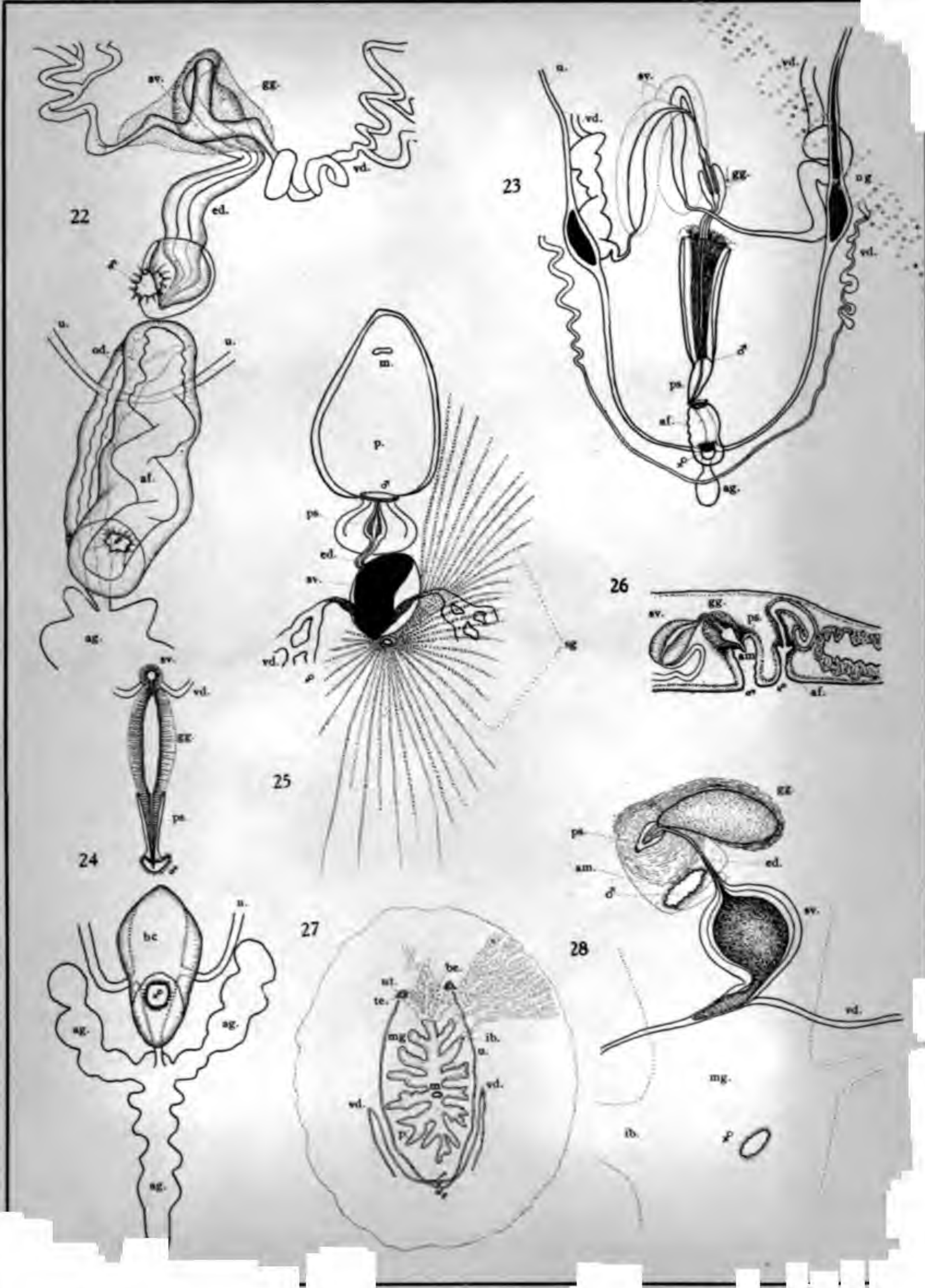
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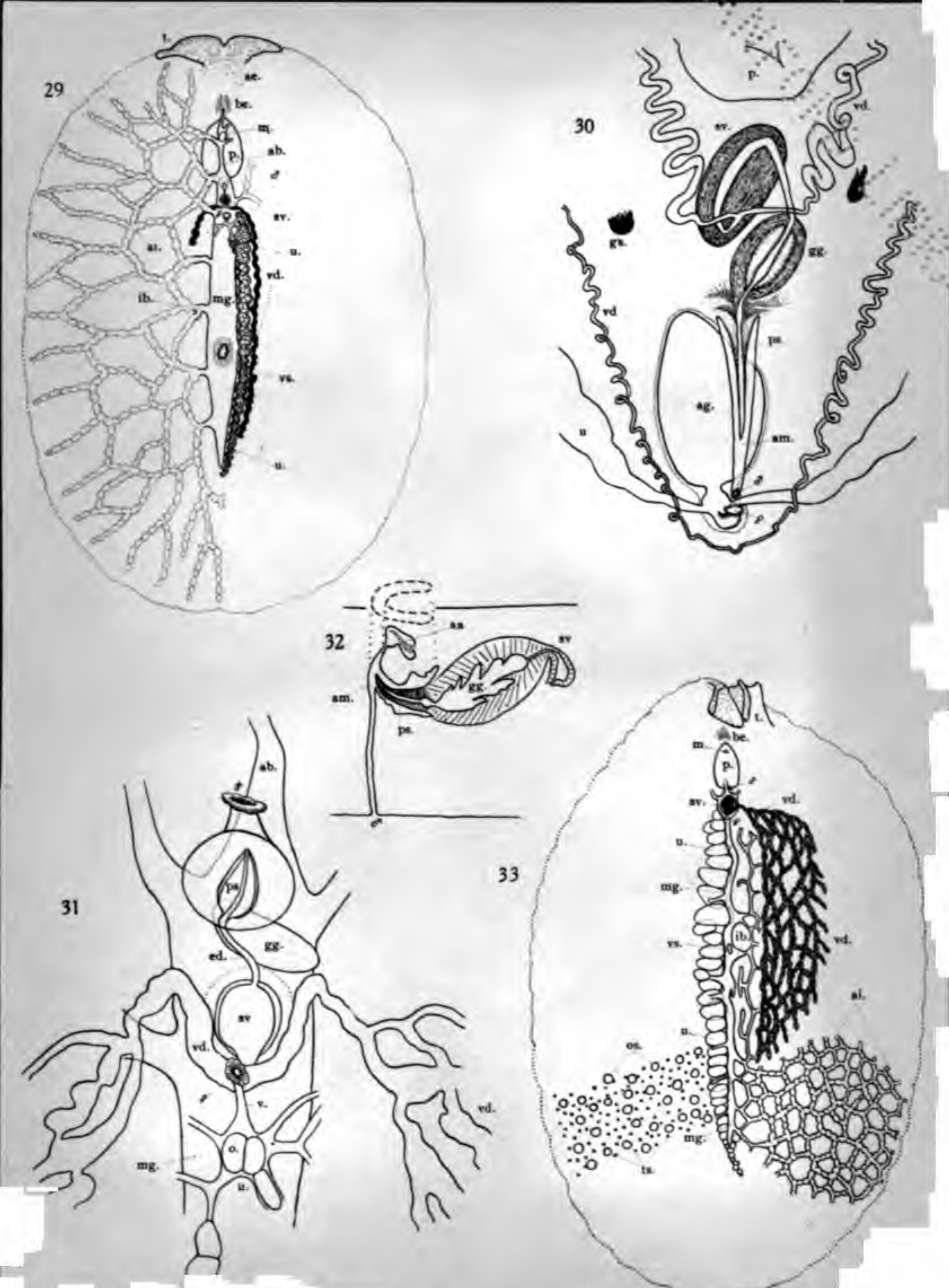
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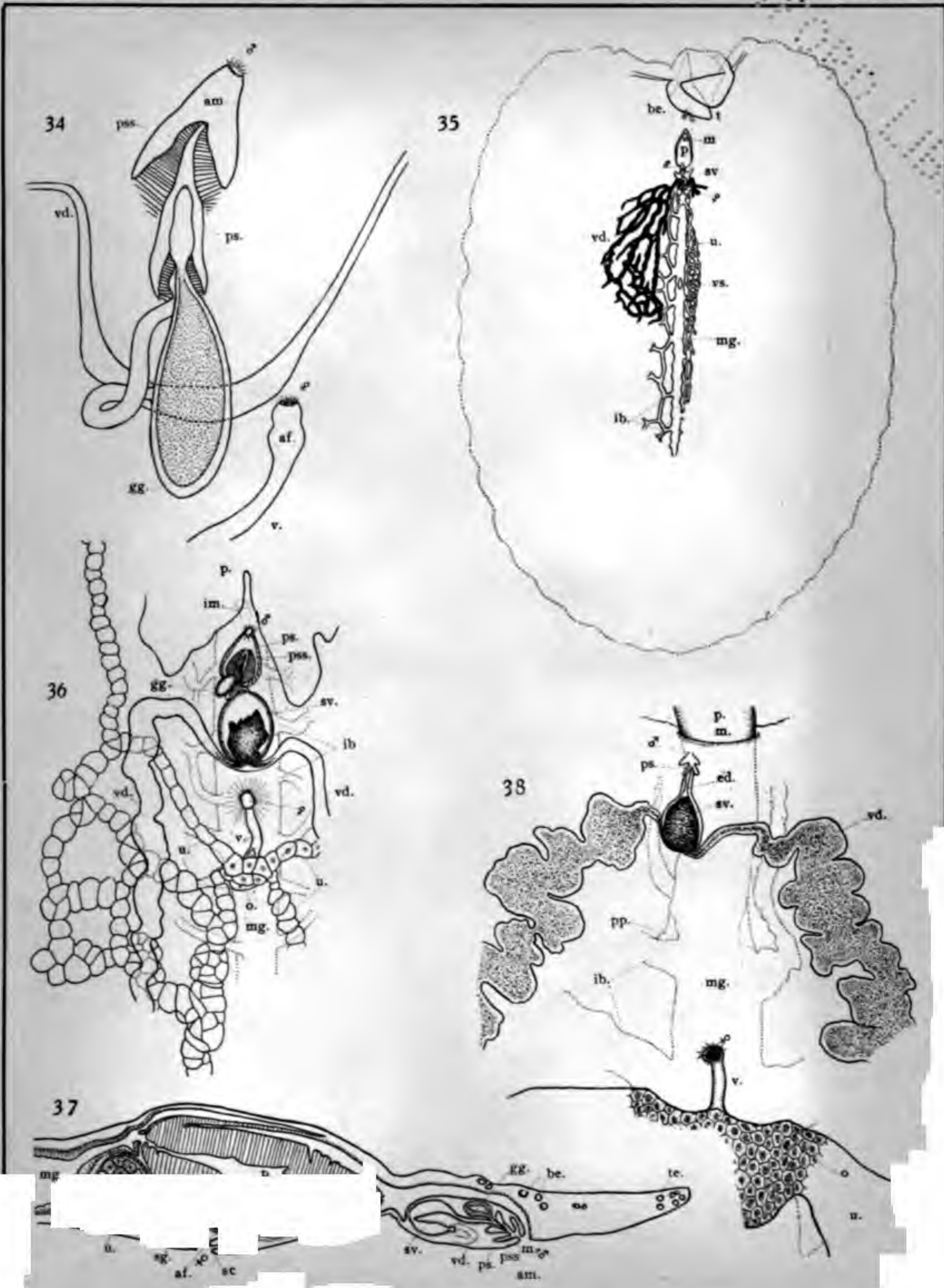
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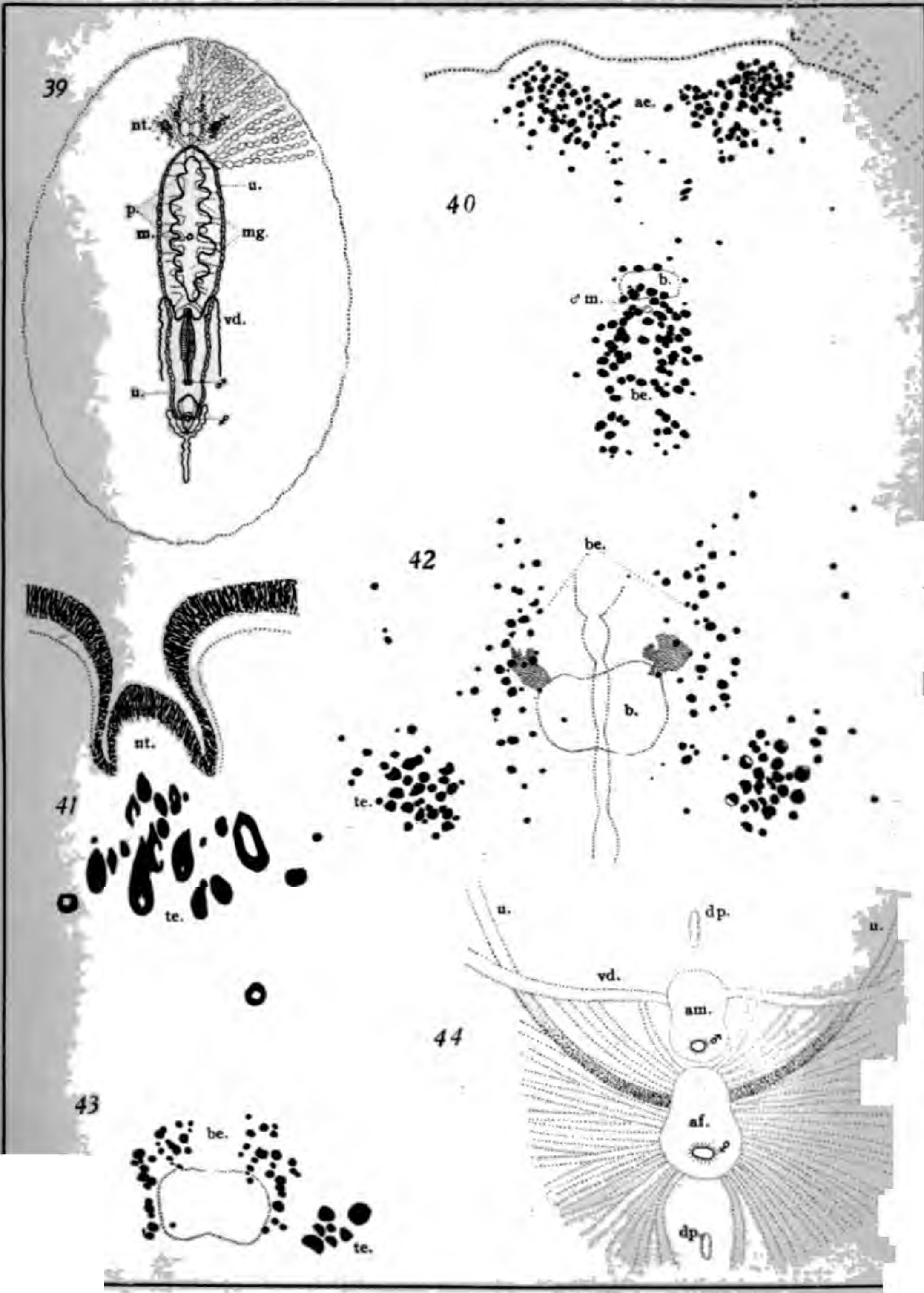

HEATH AND McGREGOR: NEW POLYCLADS.

SHUFELDT: A PREHISTORIC RACE OF YUCATAN.

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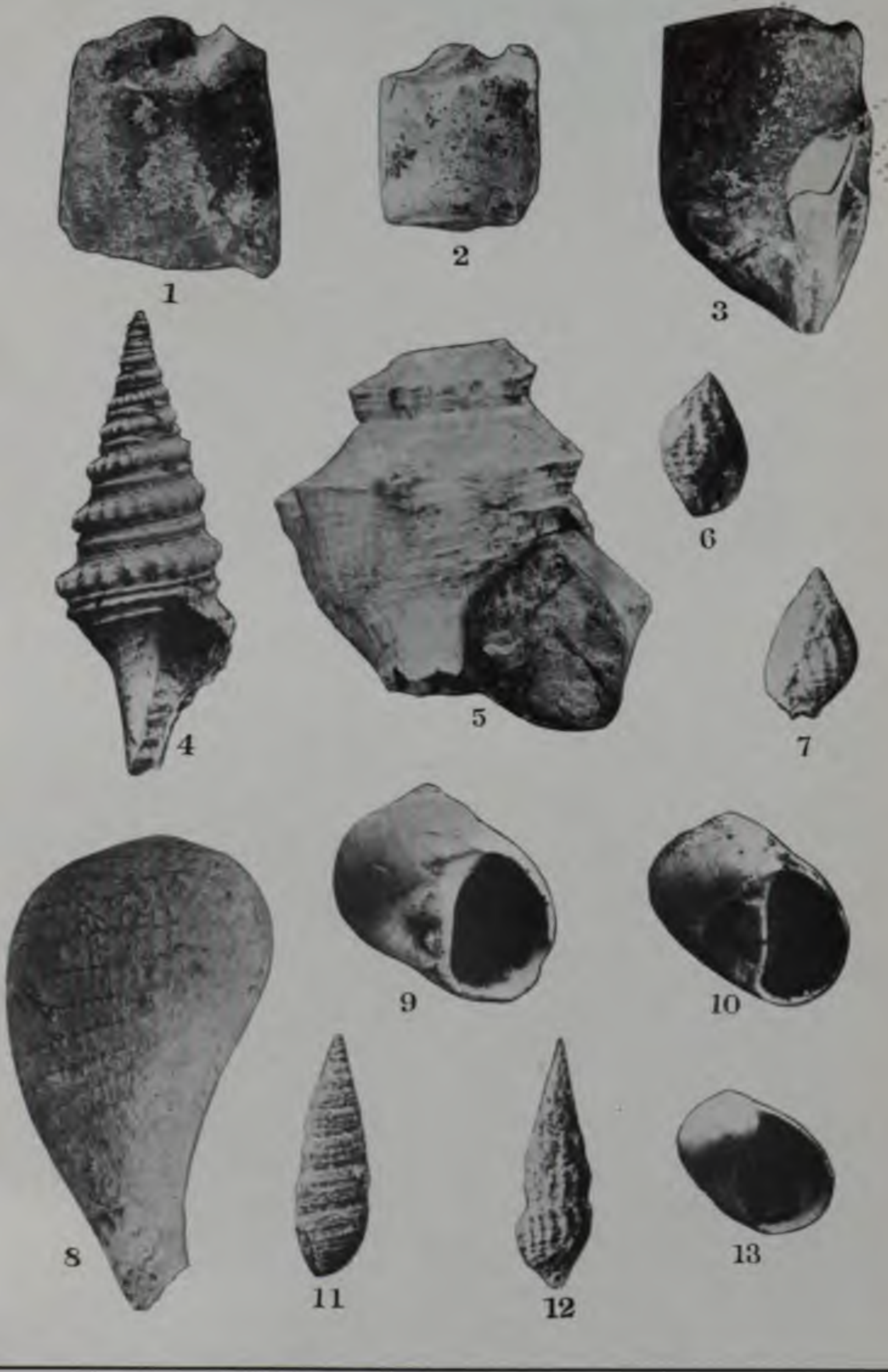
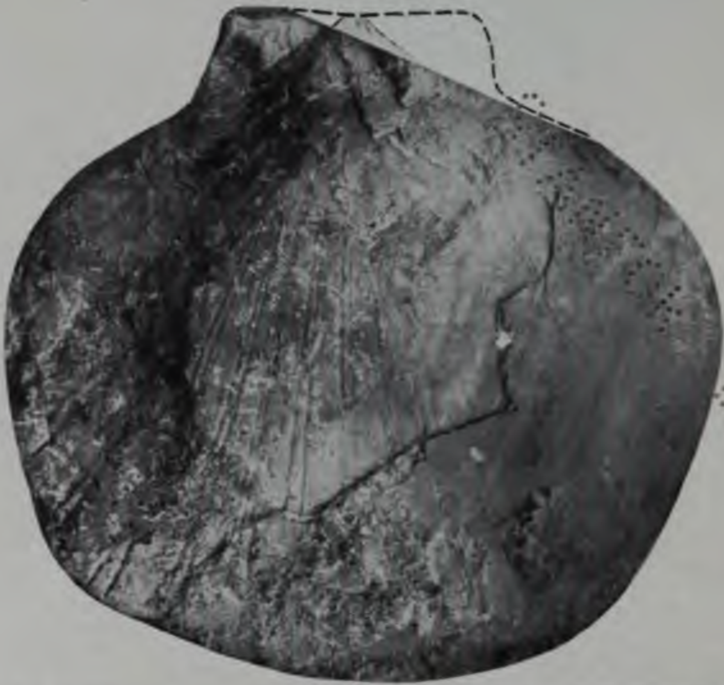


BROWN AND PILSBRY: FAUNA OF THE GATUN FORMATION.



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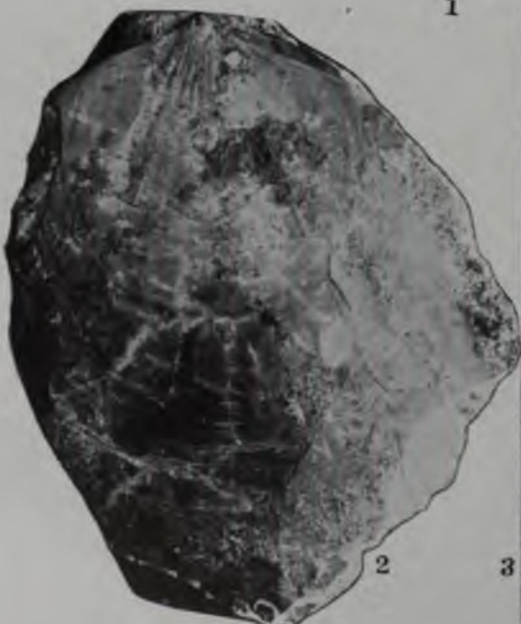

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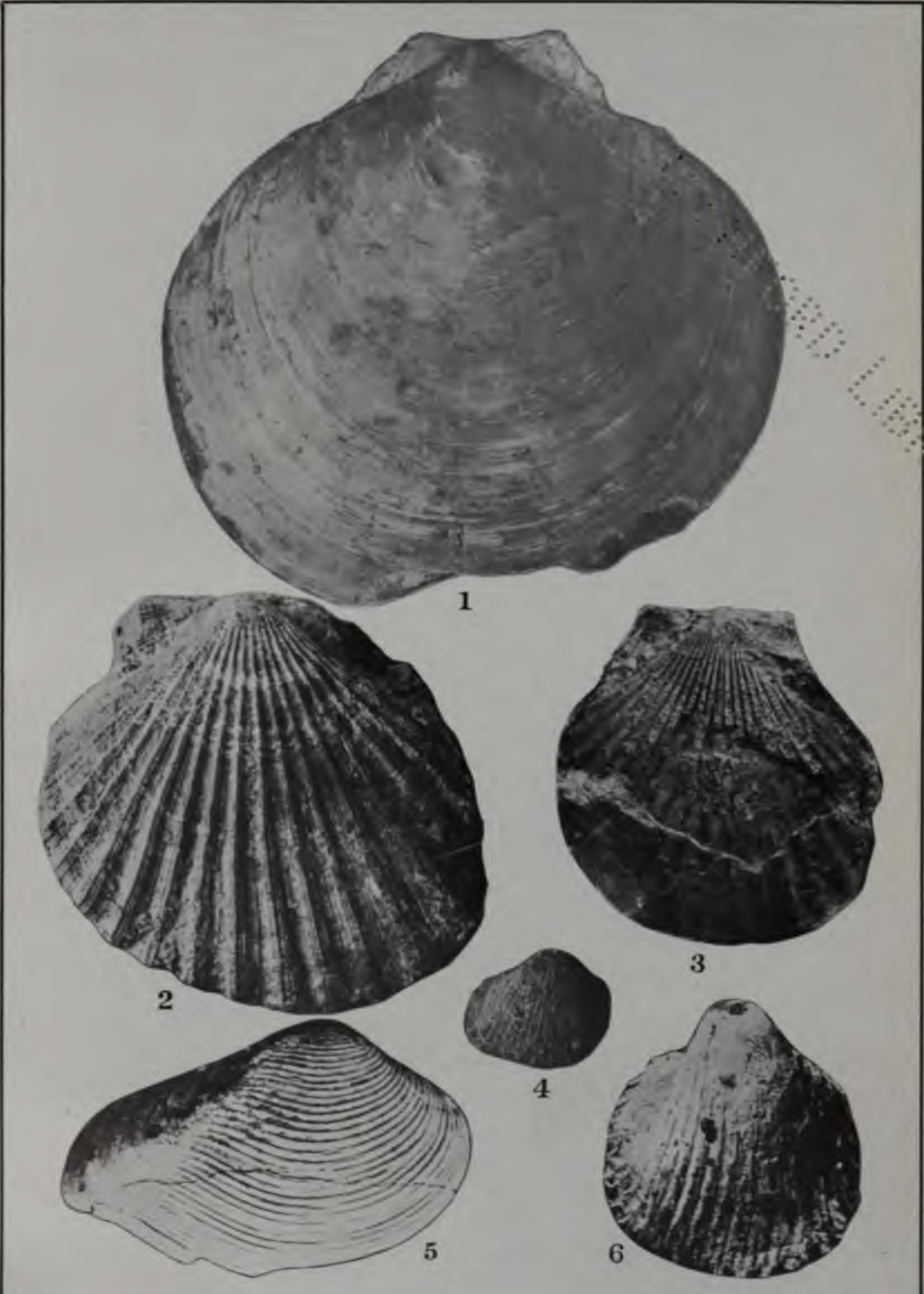

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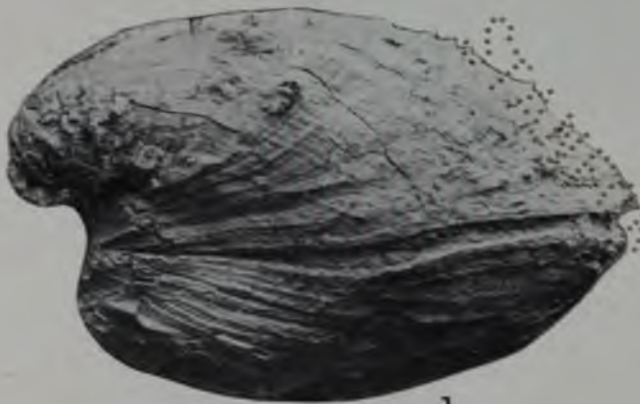

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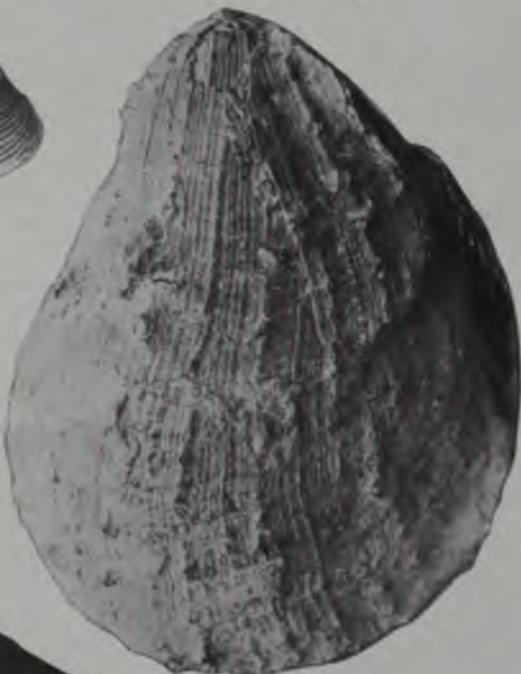

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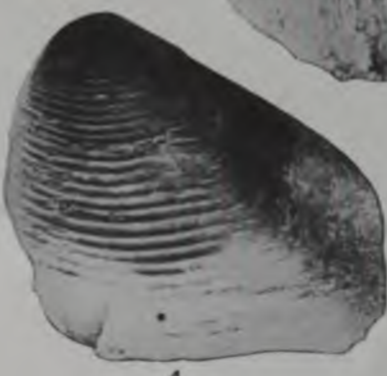

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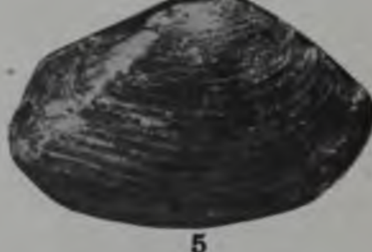

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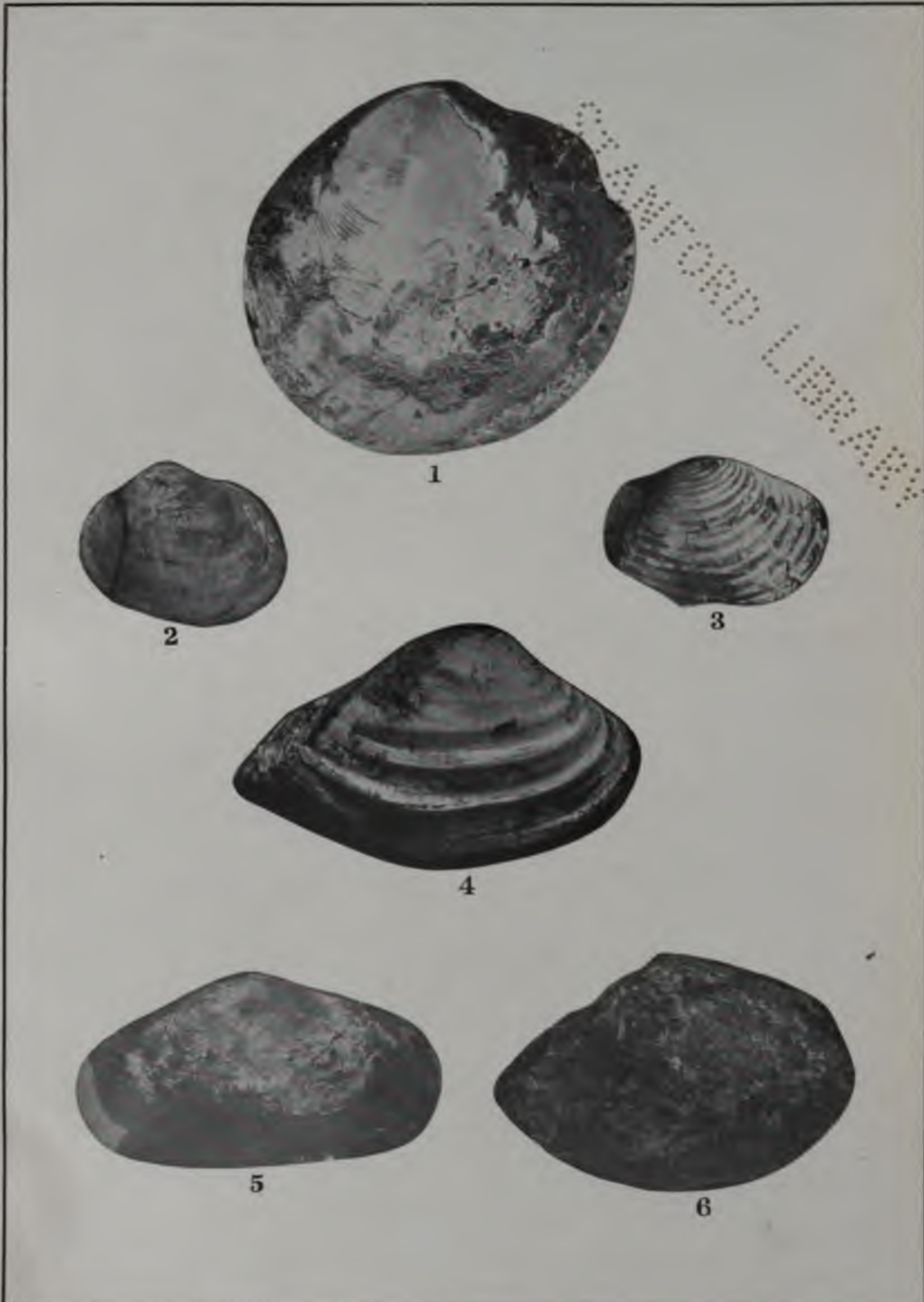

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